SCIENTIFIC AMERICAN
No. SUPPLEMENT 131

Scientific American Supplement, Vol. VI, No. 131
Scientific American, established 1845.

NEW YORK, JULY 6, 1878.

Scientific American Supplement, $5 a year.
Scientific American and Supplement, $7 a year.

Continued from SUPPLEMENT No. 124.

THE CAÑONS OF THE COLORADO.

[Compiled from the Report of Prof. J. W. Powell, Geologist in charge of the G. and G. Survey of the Territories.]

No. IV.

THE Grand Cañon is the next region in order. Its depth varies from 4,000 to 6,000 feet. At the bottom it is a narrow cleft in black granite, carved into deep gulches, with outstanding pinnacles and towers. Above are broken, ragged nonconformable rocks underlying horizontal strata. The softer of these latter have been washed out; the harder remain as shelves. Above these rust-colored shelves are soft, lemon-colored shales. Next above comes homogeneous limestone, a thousand feet thick, standing in vertical cliffs. This great bed is capped by soft sandstones, which have been worn into numerous amphitheaters and side cañons, as seen in Fig. 28. Of this region Lieutenant Ives, who explored the Lower Colorado, says: "The extent and magnitude of the system of cañons in that direction is astounding. The plateau is cut into shreds by these gigantic chasms, and resembles a vast ruin. Belts of country miles in width have been swept away, leaving only isolated mountains standing in the gap; fissures so profound that the eye cannot penetrate their depths are separated by walls whose thickness one can almost span, and slender spires that seem tottering upon their base shoot up a thousand feet from vaults below."

The Western Kaibab Fault crosses the river at the Grand Cañon with a throw of one thousand five hundred feet, dropping the lemon-colored shales down to the river bed. Still passing down stream the To-ró-weap Fault is encountered, also crossing the cañon. Many volcanic cones stand along the edge of this fault. Eruptive mountains, beds of black basalt, and volcanic cones are occasionally found, and scoria and ashes are scattered over the land. There are three great irregular masses of rock standing on the bench between the To-ró-weap Fault and the Hurricane Ledge Fault, which the Indians call the U-in-ká-ret, or Pine, Mountains. We have seen that the Uinta Mountains were not thrust up as peaks, but were carved from a vast rounded block uplifted from the ocean. But how have the U-in-ká-rets been formed? The beds of sedimentary rocks on which these mountains stand run under the Vermilion Cliffs, and the beds composing the Vermilion Cliffs once extended over this country far to the south and beyond the Grand Cañon. Shales, sandstones, and limestones several thousand feet in thickness have been completely washed away. When this denudation began the region slowly sank, and molten lava was thereby occasionally forced up through fissures. Doubtless these floods of lava poured into the valleys then existing, and covered large areas of the sandstones and shales now seen in the Vermilion Cliffs. These lavas became much harder than the rocks they covered, and as the denudation progressed, or, as the Vermilion Cliffs, which were once south of the Grand Cañon, were broken down and advanced northward, the unprotected areas of sandstones and shales were carried away, while the regions capped by the hard basalt withstood the atmospheric assaults of ages, and remain as the U-in-ká-ret Mountains to this day. Some of these lava beds are much more recent than others, and cover sandstones which had already been partially wasted. In general the older lava beds have the greater altitudes. The last puffs of these eruptions cast scoria and ashes high into the air; the lighter were carried away by the winds; the heavier fell, and thus cinder cones were formed, some of which still preserve the outlines of the craters.

FIG. 29.—THE GRAND CAÑON, LOOKING WEST FROM TO-RO-WEAP.

So we may call these mountains eruptive, for, had no eruption occurred, no mountains would have remained. Yet the great mass of the materials forming them is sedimentary strata, and these peaks may be included with the Uinta Mountains as examples of erosion.

Having noticed the most important features of the Colorado Valley, we may now review the several agencies that were active in their formation. First come upheaval and down-throw, with the several kinds of faults and folds illustrated in a previous number. The second is erosion, and its action depends upon the character of the displacements, the constitution of the rocks, and the amount and relative distribution of rainfall. The greater the altitude of a region, the more rain it receives. The power of running water in corrading channels and transporting the products of erosion increases with its velocity in geometric ratio. Another condition which determines the amount and character of erosion is climate. In a moist climate, with abundant rain, the water penetrates the rocks and breaks them up or rots them, as we may say, and the harder rocks are but little more durable than the softer; the tendency here is to produce rounded hills and mountains, and not plateaus and cliffs. In an arid country, where the rock is protected by neither soil nor vegetation, the few rains that fall beat and wash out the soft strata with great violence, and, undermining and breaking down the harder rocks, leave a region of cliffs and plateaus. The character of the river channels also varies in the two instances. In a moist climate the streams are fed by a comparatively uniform rainfall over the whole country, and their banks are eroded in gentle slopes. In an arid region the streams are chiefly supplied by the condensation on mountain peaks, and the banks are precipitous rock but little worn by the surface-wash from the surrounding country.

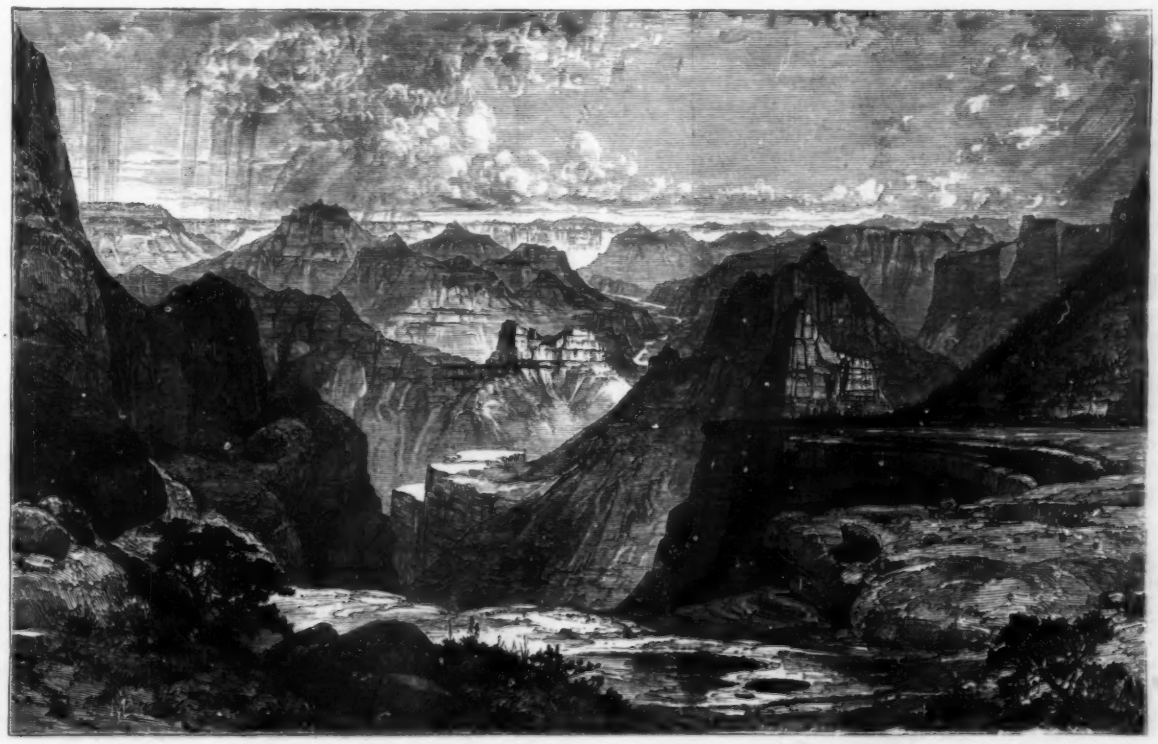


FIG. 28.—THE GRAND CAÑON OF THE COLORADO.—AMPHITHEATERS AND SCULPTURED TOWERS, CARVED BY RAINS.

That the mountain forms of this region, the cañons, the channels and gulches of rivers and intermittent streams were all carved by the running waters, the evidence is too great to question. The formation of the mountains and cañons is insig-

FIG. 30.—THE GRAND CAÑON, LOOKING EAST FROM TOROWEAP.

FIG. 34.—WINNIE'S GROTTO, 2000 FEET DEEP.

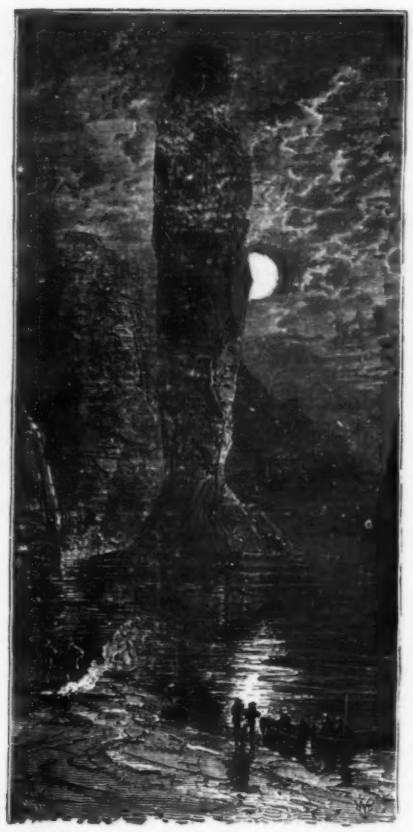


FIG. 32.—ISLAND MONUMENT IN GLEN CAÑON.

FIG. 35.—SUMNER'S AMPHITHEATRE.

FIG. 33.—MU-KOON'-TU WEAP CAÑON.

nificant, however, compared to the denudation of the whole area. Beds hundreds of feet thick and hundreds of thousands of square miles in extent, beds of granite and beds of schist, beds of marble and beds of sandstone, crumbling shales and adamantine lavas have slowly yielded to the silent and unseen powers of the air. Yet the erosion in the Colorado Valley is no greater than that in other regions. On the contrary, such is the dryness of the climate, that the erosion may be considered less than elsewhere. In other districts erosion is imperceptible; the whole country is carried away and no evidence left. In this region the very imperfection of the erosion renders its magnitude more apparent.

Nor, from the evidences collected, does it seem necessary to refer this extensive action to a former age of greater rainfall than now exists, for, as I have stated, a greater precipitation of moisture would have formed very different topographic features. Instead of cañons, there would have been

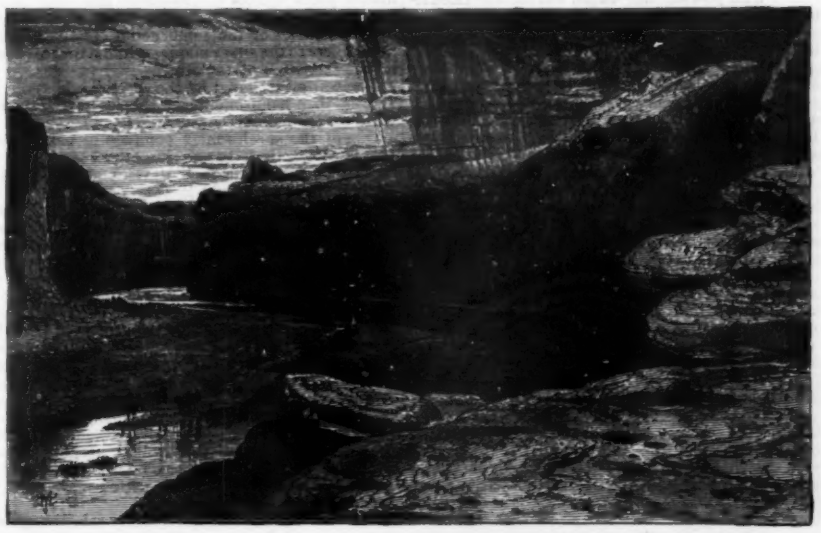


FIG. 31.—GLEN CAÑON. CAVES FORMED BY THE WASHING OUT OF SOFT STRATA.

water-gaps and ravines. Instead of valleys with cliff-like walls we should see valleys bounded by rounded hills and slopes. If my conclusions are correct, the present arid conditions must have existed during the entire formation of these cliffs, and even previously.

(To be continued.)

AMERICAN ARCHÆOLOGY.

FOR more than a quarter of a century the Smithsonian Institution has been engaged in researches concerning the antiquities of America. As the result of its efforts many important memoirs have been prepared, and published in its Annual Reports and in the Contributions to Knowledge; and the National Museum, in charge of the Institution, has become the depository of the largest and most valuable collection of American aboriginal relics in the world.

In continuation of previous effort in the same direction, the Institution contemplates the publication of an exhaustive work on American Archæology, with numerous illustrations. This will be accompanied by a series of maps, exhibiting by appropriate signs and colors the localities and distinctive characteristics of *ancient mounds and earthworks; shell-heaps; cave and cliff-dwellings; masonry; sculptured slabs or carved images; inscriptions and rock paintings; graves and cemeteries; aboriginal quarries and salt works; caches or deposits of objects in large quantities; workshops or places of ancient aboriginal industry; ancient roads or trails; and reservoirs and aqueducts.*

To this end the Institution desires to collect from every available source whatever is now known, or can be ascertained by special investigation, of the antiquities of North America; and it invites the co-operation of all into whose hands this circular may fall. If the recipient has not the time or the disposition for such inquiries, he is requested to hand it to some one in his neighborhood who is known to be, or who is likely to become, interested in such matters, with the request to correspond directly with the Smithsonian Institution upon the subject.

SPECIAL MEMORANDA.

In giving a description of any of the objects named above, great care should be taken in defining *the exact locality, the site or station, the number and manner of grouping, the shape and size, the internal structure, and the contents.*

1. *Locality.*—In locating aboriginal remains, the State (or territory), the county, the township, and the distance and direction from the nearest postoffice or railway station should be distinctly given. In addition to this it is advisable to name any well known stream, hill, bluff, or other remarkable natural feature in the immediate vicinity. Explorers usually refer a "find" to the land of some individual. This may answer for a secondary indication; but, inasmuch as lands are constantly changing owners, it should not be too much relied upon.

2. *Site or Station.*—Nearly all aboriginal constructions seem to have been erected with reference to some natural advantage; for example, upon a hill for observation or defense, by the water for fishing purposes, upon an alluvial plain or terrace for convenience to tillable land, &c. Again, there is reason to suppose that geological changes, such as the shifting of river beds, may have taken place since these erections were made. The site of the remains should, therefore, be described with reference to the surrounding country, and to the natural advantages and geological history of the location.

3. *Number and Grouping.*—However abundant earthworks and other aboriginal remains may be in any locality, on careful inspection they will generally be found in groups, having some relation to each other, to the points of the compass, or to the topographical features of the country. An accurate survey and plat, indicating each member in its place, is the most instructive method of representing the facts. Where this is impracticable the individual constituents should be carefully counted and their relative location sketched as definitely as possible.

4. *Shape and Size.*—In different portions of North America the earthworks and other structures exhibit certain conventional shapes, notably the animal mounds of Wisconsin. In order to ascertain the geographical distribution of typical forms it is very desirable to obtain ground plans and sectional drawings as accurate as circumstances will allow. In several States surveys of the most celebrated works have been made, and others are in progress. The plots of Moses Strong (Smith. Rep., 1876, 424–432) may be taken as models for ground plans. Cross-sections and elevations are important in conveying an idea of complicated works. It is well, moreover, to observe the effect of weathering and of cultivation. Notice should be taken, also, of the age of trees growing upon the work or upon lands in the vicinity supposed to have been cleared by the ancient inhabitants.

5. *Internal Structure.*—The study of the structure of an aboriginal work has reference to the nucleus or central portion, and to the enveloping mass. Leaving the former to be considered under the next heading, whatever is said here concerning structure will relate to the latter only. The internal structure of aboriginal remains depends upon their design and the material at hand, quite as much as upon the conceptions of their builders. In some the mass is homogeneous throughout; while in others there are layers of clay, mould, sand, and stone, varying in thickness and mode of distribution. By sinking a shaft from the center of the apex, or by cutting a ditch on a level with the ground, from the circumference toward the center, the structure will be revealed.

6. *Contents.*—The contents of earthworks and other ancient structures vary with the purpose which they were designed to subserve, with the locality, and, in the case of burial mounds, with the social standing of those interred within them. The greatest diversity of contents is found in the mounds of the Mississippi Valley, which, indeed, have been named burial, sacrificial, domiciliary, and defensive mounds, according to the end which they seem to have served. The most desirable objects among the contents of these mounds and other earthworks are the human remains. In order to preserve the crania and bones, as well as bone implements or other friable objects, they should be covered with boiled oil, or with a weak solution of warm white glue. When this has dried sufficiently, the process may be repeated until the tissue is completely hardened. Small fragments may be immersed in the liquid at once. Where it is practicable to save crania and other fragile objects entire, the glue may be applied before they are removed from the earth. Dr. Otis, of the Army Medical Museum, has succeeded in taking out a block of earth containing the skull, and by repeated washings and application of the glue has saved some very frail specimens. The Société d'Anthropologie de Paris has issued two pamphlets of instructions, indispensable to collectors of human remains, viz., "Instructions Craniologiques et Craniométriques" and "Instructions Générales pour les Récherches Anthropologiques." With regard to the nucleus and to aboriginal relics contained therein, the explorer should examine every object in the position where first discovered, with reference to the original level of the ground, to the structure of the tumulus, and to the objects buried with it. He should disregard no object, however insignificant it may seem, and record with the most scrupulous accuracy whatever is observed. With reference to shell-heaps as well as to mounds there is evidence that the work of erection was abandoned and resumed at longer or shorter intervals, and that a long time elapsed between the commencement and completion of some of them. This would be indicated by a difference in the character of the deposits, by a change in the mode of burial, and by the more or less decayed condition of the bones found in each layer. Many interesting problems concerning race, migration, commerce, cannibalism, cremation, trepanning, disease, &c., are to be solved by an exhaustive comparison of the contents of these aboriginal constructions.

In addition to original records and descriptions concerning the objects enumerated above, the Smithsonian Institution desires to obtain copies of all books, memoirs, pamphlets, extracts from periodicals, and newspaper clippings having any relation whatever to American archæology. It also desires to be informed of the locality of all collections of American antiquities, however small, whether in private hands or in public museums. Special information concerning these collections, the number and character of the most perfect and choice specimens, together with photographs, tracings, or other drawings of the same, will also be valuable, and may enable the Institution to publish a directory of all the archæological collections in the United States.

In conclusion, the Smithsonian Institution respectfully and urgently invites contributions of specimens of aboriginal art and antiquities from all sources and from every part of the country, to be placed in the National Museum at Washington, and preserved permanently in a fireproof building under careful supervision. The object in view is not merely to possess every variety of article, but also to ascertain the geographical distribution of each form. In this manner, important information may be obtained as to the migrations and commerce of the ancient races.

All specimens contributed will be duly accredited to the donor in the reports of the Institution, in the proposed work on American Archæology, and on the labels of the specimens; so that, wherever the object may be, the source whence derived will be known. Instructions will be given by the Institution, on application, as to the best method and route of transmission of such collections, the freight on which will be paid on receipt in Washington.

JOSEPH HENRY,
Secretary Smithsonian Institution.

INFORMATION DESIRED AS MATERIAL FOR AN ILLUSTRATED WORK ON THE ARCHÆOLOGY OF NORTH AMERICA.

Name of correspondent.
Occupation.
Post office address.
Date of communication.

GENERAL INQUIRIES.

[Answers to the accompanying questions may best be made by reference to the numbers, without repeating the interrogatories.]

1. Are there any remains of ancient aboriginal structures, such as mounds, earthworks, shell-heaps, &c., in your vicinity?
2. Are there any other indications of a former occupation of the region by the aborigines?
3. Where are they located? Give State, county, nearest postoffice, distance and direction from some well known natural feature, and the name of the owner of the property at the date of the report.

MOUNDS AND EARTHWORKS.

4. How are they situated with reference to streams and springs of water, elevations, tillable land, or other natural features?
5. What changes, if any, have taken place in the streams, forests, and other surroundings since their erection?
6. Are the mounds isolated or in groups?
7. If the latter, what is their number and relative position? Furnish a sketch or plan, however rude it may be, with the individual mounds of the group, numbered. A topographical survey is most desirable, where it is convenient.
8. What is the size and shape in ground plans, in section, of each member of the group? Of irregular and animal mounds a sketch with measurements of the different prominent parts should be given.
9. Of what material are they composed?
10. How is this material arranged, especially near the center?
11. What is the construction of the center of the work?
12. Where was the material used in the formation probably obtained?
13. Have any of the mounds been explored? Designate which ones on a plat.
14. If explored, what archæological objects were found in them?
15. What have become of those objects?
16. If any account of them or of the explorations has been published, where, and by whom?
17. Have the mounds or earthworks been injured by weathering or by cultivation?
18. Are trees growing upon any of them? If so, of what kind and dimensions?

SHELL-HEAPS.

19. What is the number of shell-heaps in your vicinity?
20. What is the location of the deposits with respect to the water and other natural features?
21. Has there been any change in the shore to submerge them, to carry a portion of them away, or to bring them above the water line and away from the beach?
22. What is the length, breadth, and depth of each?
23. Of what are they composed? Collect specimens of each species of shells.
24. What is the nature and depth of the superincumbent soil?
25. What vegetable substance used as food or for other purposes occurs in them?
26. What animal or human remains have been found in them?
27. Were the bones whole, charred, or fractured?
28. Were any wood, bone, shell, or stone implements, or ornaments, or pottery discovered?
29. What were the characteristics of these objects? Make drawings or photographs if practicable.

CAVE AND CLIFF-DWELLINGS.

30. Have any caves or rock-shelters in your section of the country ever been used by the aborigines for a dwelling?
31. What advantages do these places furnish for defense, for accessibility to water, game, and other means of living?
32. Are there any indications of an attempt to improve or strengthen these places?
33. What relics of man or of his works were found, and under what conditions?

MASONRY.

In the southwestern portions of our country and from thence to the Isthmus, remains of stone and adobe structures are to be seen. If any have been found in your section—

34. What is the material of which they were built?
35. What uniting substances, if any, have been used?
36. What is the plan and probable use of the structure?
37. What attempts were made at ornamentation?
38. Is there a central excavation or estufa?
39. Was the building more than one story high?
40. How is it situated with reference to protection and convenience?
41. What relics were found in it?

SCULPTURED SLABS AND CARVED IMAGES.

In portions of the Mississippi Valley specimens of rude statuary have been found, and further south in Mexico and Central America large slabs occur covered with sculpture.

42. If sculptures occur near you, under what conditions were they found?
43. With what other remains were they associated?
44. If slabs, have they been injured by weathering?
45. Has any account, illustrated or otherwise, been published?
46. If they have been removed, in whose possession are they now?

ROCK-PAINTINGS AND INSCRIPTIONS.

On cliffs and bowlders carved and painted inscriptions have been found.

47. If any occur in your neighborhood, what is the precise location?

48. Is the design executed with paint or in sculpture?

49. What figures are represented? Give a sketch or photograph if practicable.

ABORIGINAL BURIAL.

50. Are the dead found in isolated graves, cemeteries, ossuaries, caves, or mounds?

51. Are the graves which are in groups arranged according to any plan?

52. Are they on a level tract or on a slope?

53. If the latter, what point of compass does it face?

54. Does each grave contain the remains of more than one individual?

55. Were the bodies buried in a sitting posture, stretched out, lying on the side and doubled up, or were the bones mingled indiscriminately in the grave?

56. Was the head or face of the dead directed to any particular point of the compass?

57. Are the remains simply buried in the earth, or are they inclosed in stone circles, in cysts, in earthen jars, or in some other receptacle?

58. In what state of preservation were the bones found?

59. Are the graves deep or shallow?

60. Have they been injured by weathering?

61. Is there any evidence of desiccation, mummification, cremation, or other special treatment of the remains of the dead previously to interment?

ABORIGINAL QUARRIES.

62. If any ancient quarries have been discovered, what is the material which was sought by the aborigines?

63. What is the locality, depth, and form of the excavation?

64. What evidence exists of the manner of detaching and working the material?

65. What and what kind of mining tools have been discovered?

CACHES.

Various kinds of aboriginal implements have been found deposited in large quantities as if designedly.

66. If caches have been found, what was the number, and character of the contents?

67. Where and under what circumstances were they found?

68. Were the objects kept together by the discoverer, or scattered? If the former, in whose possession are they now?

WORKSHOPS.

At certain seasons of the year some of our Western tribes encamp in the neighborhood of deposits of jasper, chalcedony, and other minerals valuable for arrow-making, and manufacture a sufficient quantity of points, knives, &c., to last them a long time. The ground around such places, for several acres, is covered with splinters, cores, spoiled points and flaking tools.

69. Are there any traces of the manufacture of stone implements or pottery in large quantities in your vicinity?

70. If so, what is the character of the refuse?

71. Has this refuse been subjected to the action of running water, and what is the method of its aggregation under such influence?

ROUTES AND TRAILS.

72. What vestiges, if any, exist in your section of ancient trails, carrying places, fords, bridges, stone-heaps, landmarks, and whatever else would throw light upon ancient migration and commerce?

RESERVOIRS AND WATER COURSES.

73. Have any attempts been made by the aborigines of your region to construct aqueducts or reservoirs for water?

74. Do the aqueducts show any especial skill in following the natural level?

75. What is the length and other dimensions of the channel?

76. Were any attempts made at irrigation?

77. What is the size of the reservoirs, if any exist?

78. How are they lined?

79. How were they supplied with water?

BIBLIOGRAPHY.

80. Do you know of any original memoirs or surveys of these remains that have not been published? Please send the name and address of the individual who has them in possession.

81. Have any accounts of the antiquities in your neighborhood been published by your local press? Can copies be procured?

82. Have they been described in any other publication, such as magazines, proceedings of learned societies, &c.?

83. Are there any public or private collections of antiquities in your locality?

84. If so, do they contain rare and valuable specimens?

85. Have these specimens ever been figured? Drawings or other representations of those that are rare will be gratefully received by the Institution.

86. What specimens can you furnish as a contribution to the National Museum?

FOREST-TREE BORERS.

By MARY E. MURTFELDT, Kirkwood, Mo.

THE insects that openly attack the staple crops of the field and orchard are but few in kind compared with the almost countless species that more indirectly but none the less surely militate against our enjoyment and our pecuniary interests.

Among the most important insects of the latter class are the forest-tree borers. The rapid decadence of our forests, so noticeable in many sections of the country, and the unreliability of indigenous shade trees around our dwellings, is in a large measure due to the insidious work of these insects.

Many of the most destructive species are of the utmost insignificance individually, but in the aggregate become a formidable scourge, before whose attacks the stateliest monarchs of the forest fall into ruin, often within a single year.

The described species of American forest-tree borers number several hundreds, but the greater proportion of the injury is done by not more than twenty-five or thirty species, all of which are included in the order *Coleoptera* (beetles). A few boring larvæ occur in the orders *Lepidoptera* (butterflies and moths) and *Hymenoptera* (four-winged flies), but, as a rule, the beetles enjoy a monopoly of this sort of work.

The wood-boring beetles belong to several widely different groups, and are classified according to their habits or structural peculiarities, as bark-borers, wood weevils, sawhorn borers, or *Buprestians*, and long-horn borers, or *Capricornes*.

The bark-borers are all included in the family *Scolytidæ*, and are characterized by their hard texture, polished black or dark colors, short, clubbed antennæ, and by their nearly cylindrical form, which is truncated either squarely or obliquely behind. Few of the American species exceed one-fourth of an inch in length. Both sexes of these beetles bore into bark, the males in quest of food merely, and the females for the additional purpose of laying their eggs. The latter are placed on either side of a vertical burrow, cut partly in the inner bark, partly in the sap wood. The larvæ are fleshy, wrinkled, legless grubs, closely resembling curculio larvæ, and, like the latter, always rest in a curved position. They bore transverse diverging grooves, forming fanciful patterns on the inner bark, and corresponding ones on the sap wood. These burrows, which in the rear of the grubs are filled with powder and chips, cut off the circulation of the sap, and when at all numerous, speedily cause the death of the tree. The grubs attain their growth during their first summer, and remaining dormant over winter, change to pupæ in the spring. The beetles issue soon after through small round holes in the bark, badly infested trees presenting after their emergence "the appearance of having been peppered with No. 8 shot," as Prof. Riley remarks in reference to the Hickory Scolytus. The species belonging in the genera *Hylurgus* and *Tomicus* are mainly injurious to pines and other evergreens, while those included in *Scolytus* attack for the most part hard-wooded, deciduous trees. *Scolytus 4-spinosus* of Say bores the hickory and pecan, and although a small species, is, on account of its exceeding prolificacy, one of the most destructive timber pests, and has been known in many instances to cause the death of entire groves of valuable trees within a single season. It works by preference in young trees and in the tops of the larger ones, where the bark is most penetrable. Nature has fortunately provided a check upon the increase of this insect in the shape of two small parasitic flies, which penetrate to the grubs through the holes made by the parent beetles, and lay their eggs upon the bodies of the former, which the fly larvæ, upon hatching, proceed to devour at their leisure.

The wood weevils include but few species of the Snout-beetles (*Curculionidæ*), as this family is mainly composed of species that inhabit fruits, nuts, and grains. Those which live in wood are similar in their habits to the true Bark-borers, but are readily distinguished from them by the prolongation of the front of the head into a straight or curved stout beak or snout, upon which are situated the elbowed and knobbed antennæ. They are chiefly injurious to trees of the pine family. The larvæ of some of the species bore the pith of the twigs and smaller branches, while others gnaw galleries under the bark, similar to those formed by Scolytus, only not so fanciful in design. One species of *Magdalis* affects the willow and another inhabits the elm.

The Saw-horn Wood-borers or Buprestians include many of the most pernicious species. They are easily recognized by their flattened, oblong form, hard texture, metallic colors—generally brighter beneath than above—short legs, and rather short, serrate antennæ. They are diurnal in their habits, and the trained observer often comes across them basking in the sun during the middle of the day upon the trunks of the trees they infest. When disturbed they instantly draw up the legs and drop to the ground, after the manner of the Snout-beetles. The eggs are laid in crevices of the bark, through which the larvæ penetrate to the sapwood. Here they work during their earlier stages, but upon approaching maturity cut channels in all directions through the solid wood. The larvæ of the Buprestians are at once distinguished from all other wood-boring larvæ by the excessively enlarged and depressed first-joint, into which the small head, with its dark, horny jaws, is partly retractile. The second and third thoracic joints diminish rapidly in size, and the hind body presents a comparatively attenuated appearance.

Our largest species, *Calcophora* (*Buprestis*) *virginiensis*, is about an inch in length, of a blackish color, with coppery reflections. Its larva bores the trunks of the pine, causing considerable destruction in pine forests. *Dicerca divarica* of Say, which infests the wild cherry as well as the peach, is about three-fourths of an inch in length, copper colored, with a granulated surface, the tapering wing covers terminating in two blunt projections. The larva of a much smaller and more inconspicuous species, *D. lurida*, bores the hickory. The most numerous and most generally destructive insect of this family is the well-known "flat-headed borer," the larva of *Chrysobothris Femorata*, a brassy black species, about half an inch in length, familiar to all fruit growers as a dreaded orchard pest. This species not only attacks the apple, peach, and other fruit trees, but is particularly destructive to oak, hickory, wild cherry, and soft maple, annually causing the death of a considerable percentage of these trees, the timber of which is rendered useless for any other purpose than that of firewood by the numerous channels cut through it in all directions by the grubs. All the Buprestians complete their growth and transformations within a year, the beetles appearing early in the summer, and laying their eggs for another generation of destroyers.

The last family of beetles to be considered in this connection are the Long-horned or Capricorn beetles (*Ceramlycidæ*). These are characterized by an elongate, rather slender, subcylindrical form, long legs, and especially by the long, tapering antennæ, which are curved forward or backward, or waved gracefully through the air. Many of the species display beautiful colors, and are adorned with stripes and spots dispersed in elegant patterns. When captured, or in any way excited, these beetles make a squeaking sound by rapidly rubbing the first joint of the thorax against the second. Upward of five hundred American species are described, although the larval habits of a considerable proportion of them have not yet been investigated.

The larvæ are pre-eminently wood-borers, none of the species, so far as known, living externally on plants or feeding on anything else besides ligneous tissue or pith. They are elongate-oblong, yellowish-white grubs, with small head and strong jaws admirably fitted for drilling through solid substances. The incisions between the joints are deep, and the diameter nearly uniform throughout, the thoracic joints being but slightly enlarged. The majority of these larvæ are provided with six pointed, scaly legs, one pair on each of the first three joints, while a few are entirely destitute of legs, or have the latter represented only by three pairs of tubercular points. Some of these species complete their development within a single year, while with others two or three years elapse between the entrance of the larva into the tree and the emergence of the beetle.

The hickory is bored by a greater number of distinct species of Longicorn beetles than any other of our forest trees. Conspicuous among these is the Banded Borer (*Cerasphorus Cinctus*). This species is over an inch in length, with very long curved antennæ. The color is a pale gray-brown, each wing cover being ornamented with an oblique curving band of dull ocher-yellow. The larva after entering bores with the grain of the wood, occasionally cutting a channel transversely to the surface for the ejection of its castings, and, finally, one for the exit of the beetle. Many pieces of timber designed for manufacturing purposes are spoiled by the unexpected advent of this beetle; and it not unfrequently damages manufactured articles by cutting its way out of them, often at the very point where strength and solidity are most requisite. Another almost equally pernicious borer is the Painted Clytus (*Clytus Pictus*), a large, velvety-black species, elegantly ornamented with straight, curving, and V-shaped transverse stripes of sulphur-yellow. This species is undistinguishable in appearance from the common locust borer (*Clytus Robiniæ*), whose ravages have within the last fifteen years almost exterminated that once popular shade tree, the black locust. Another still larger and more gayly colored species of the same genus (*Clytus Speciosus*) is very destructive to the sugar maple; while a fourth (*Clytus Capreæ*) infests the trunk of the ash.

The walnut is bored by the Red-shouldered Apate (*Apate Bassilaris*), a handsome black species having the bases of the wing covers red.

One of the species most common in oak is *Asemum Moestum*, a small, dark brown insect, whose larvæ are said to require two years for their development. The Oak Pruner (*Elaphidion Parallelum*) is very destructive to the smaller branches, not only of the oak, but of a great variety of forest trees. The beetle is a slender, inconspicuous, grayish-brown species. The larvæ bore in the direction of the tree, and when mature gnaw a transverse groove in the solid wood, leaving only the thin outer bark intact. They then retire backward an inch or more, filling up the space in front of them with their chips. The winds soon break off the nearly severed branches, and the ground in wood lots is often strewn with them, each of which, if cut open early in the spring, will be found to contain either grub or pupa.

Another very singular insect of this family is the Twig Girdler (*Oncideres Cingulatus*). It deposits its eggs singly in the small branches of hickory, persimmon, crab apple, and other trees, both wild and cultured, and after having done so, completely girdles the twig at a short distance below. This procedure is prompted by the instinct of the parent beetle to provide her progeny with dead but still fresh wood for their subsistence.

The elm, the beech, the prickly ash, the pine and other trees have their own particular borers among the Longicornes, as well as some which they share in common. But the enumeration and description of the various species would extend this paper beyond all reasonable limits. I will therefore conclude with a few words on the vitally interesting subject of remedies or preventives.

As far as the forests are concerned, man is utterly powerless against these liliputian foes. He must leave all to nature, who, fortunately, takes care to prevent the extinction of one indigenous species, be it plant or animal, by another. Our forests are not, consequently, entirely abandoned to the unchecked ravages of the insects just enumerated. Undue multiplication is measurably prevented by parasitism. The parasitic species are mostly four-winged flies, belonging to the family *Ichneumonidæ*. These flies are endowed with a subtle perceptive faculty by which they are enabled to determine the exact location of the hidden borer, and by means of their long ovipositors they pierce to its retreat and consign their eggs to its body. From these eggs hatch maggot-like larvæ, before whose voracity the grub soon falls a victim.

Besides the enemies of their own class, a vast number of boring larvæ are annually destroyed by birds. We little know to what extent we are indebted to these feathered minstrels for comfort and æsthetic enjoyment we derive from trees. They not only destroy myriads of caterpillars and leaf-rollers that devour the foliage, but a large number prey habitually on the boring grubs. Some of them, like the little Nutchaches (*Sittidæ*), Creepers (*Certheriidæ*), and a few of the Warblers, particularly the little black and white Creeping Warbler (*Mniotilla varius*), are constantly running up and down the trunks and larger branches of trees, peering with their little bright eyes into every crack and under every scale of the bark in search of the insects that commonly lurk there. The Woodpecker also, especially the Red-headed Woodpecker (*Melanerpes erythrocephalus*), and the Flicker (*Colaptes auratus*) are valuable conservators of trees. They perceive and follow up the traces of a borer with undeviating accuracy, nor cease their drilling until it is disclosed. Even the much maligned Sapsucker (*Sphyrapicus varius*) probably does more good than harm. At least he is rarely found to attack perfectly sound trees.

Forest trees standing separate around our dwellings may be protected in great measure from the attack of borers by having the trunks occasionally rubbed over with common brown soap or washed with soft soapsuds. This substance seems to be distasteful to the beeties, and they will not lay their eggs on bark where it has been recently applied. If such trees are carefully watched, the presence of a borer is readily detected by its sawdust-like cuttings, and it may be killed by probing the channel with a wire.—*Western Review.*

THE FIRE-BUSH.

OF the unique collection of choice and rare shrubs which the refined and cultivated taste of W. E. Gumbleton, Esq., has brought together at his charmingly situated marine residence, Belgrove, Co. Cork, the glory and the pride just now is the South American Fire-bush (Embothrium coccineum). Just fancy a tall, handsome, dark, glossy-leaved evergreen shrub or rather tree, as early as the close of April and first week of May, all aglow with woodbine-like flowers, but of the most vivid scarlet, and the reader will form some idea of the wondrous beauty of this, perhaps, the most striking of flowering trees or shrubs. We are not aware that it has flowered elsewhere than at Belgrove in this country—in fact, the places might be counted on the fingers probably where it is to be found at all. This should not be the case, for no one who admires a beautiful out-door shrub but should ambition the possession of this very fine thing. It is apprehended, no doubt, that it is only in such climates as Cornwall, or the south or south-west of Ireland, that it will flower. This opinion, we should think, might be advantageously modified, and the experiment tried at all events in various localities. Besides, if the tree never flowered, as a handsome evergreen it is worthy of a conspicuous position among the most select. It would probably suffer from exceptionally severe frosts, but so, too, have we seen the arbu

tus and the common laurel, and yet no one thinks of ignoring them on that account. For its introduction we are indebted in this as in the case of so many other good things to Messrs. Veitch & Sons, Chelsea. This is about the third year since it first flowered at Belgrove, so that it is not very slow to reward an investment with a return that the investor cannot fail to be proud of.—*Dublin Farmers' Gazette.*

CHROMO-PHOTOGRAPHY.

A NEW ALBERT-TYPE PROCESS THAT REPRODUCES COLOR IN PICTURES.

THE great improvements in making cheap and faithful copies of valuable works of art by photo-lithography now bids fair to be far exceeded by processes discovered by Mr. Albert, court photographer, of Munich, Germany, but so far improved upon by Mr. Edward Bierstadt, of this city, that the latter artist feels confident that he will soon be able to produce copies of landscapes, portraits, and oil paintings in general, which shall be not only exact counterparts of the originals in tone, color, and effects, but which can be sold at prices even lower than those asked for ordinary photo-lithographs. The first specimens of this new chromo-photography, exhibited in this city, are from Mr. Albert's laboratory, and are faithful copies of certain tapestries, much valued by the King of Bavaria. One is an elaborate pattern of ferns, palms, and creeping vines, the background of which is a delicate summer sky. The others are representations of the vagaries in color and pattern of a designer of tapestries. Each picture was made from three negatives of the pattern copied, produced by some modifications of the Albert-type process.

Albert-typy is a method of reproducing photographic impressions by the medium of printers' ink. Many specimens which were exhibited at the Centennial Exposition of 1876 were placed far in advance of the ordinary photographic effects, and were thought to be more faithful copies of the originals than could be produced by the tools of the most skilled engraver. A perfect representation of the object wanted for a picture is the aim of the artist and engraver; and photography, as developed prior to Albert's discovery, was the only faithful copyist. Its limitation in value was the perishableness of the materials employed and the lack of color. Albert's pictures are, as far as appearance goes, photographs; but they are reproduced upon an ordinary lithographic printing-press and with printing-ink, one of the most indestructible agents known. Cardboard, paper, cloth, or silk may be the material which receives the impression, and the process thus widens the range of its usefulness to views of machinery or merchandise, as well as map drawing and copies of works of art.

The Albert process consists in coating a piece of plate-glass with gelatine, made sensitive by treatment with bichromate of potash and dried in the dark. A photographic negative made in the usual manner is glued on the side of the glass plate opposite to the gelatinized surface, and the plate is exposed to a strong diffused light, with the negative toward it. The effect of this is to harden the gelatine in proportion to the light that has penetrated the negative. When the impression so made upon the gelatine has been sufficiently developed, the plate is immersed in cold water, to wash out the remaining bichromate of potash, after which it is ready for the press.

It is in the printing that the peculiar merit of the process is shown. Gelatine is soluble in water only when heated above ninety degrees; still, its surface absorbs a little water when it is newly set, even at about fifty degrees. Those parts, however, which have been subjected to most light, namely, the tracings of the picture, are hardened by the light beyond the power to absorb water unless at high temperature; consequently, when the surface is sponged, those parts previously subjected to much light absorb water enough to repel printers' ink, while the other portions accept it more or less shaded, in proportion as they have been subjected to a more or less intense light. When the paper or bristol-board backing for the picture is passed through the lithographic press in which the negative is fixed, a clearly-shaded, faithful reproduction of the original picture is left upon it, which may be reproduced many hundred times by simply rewetting and reinking the gelatine after each impression.

Messrs. Harroun & Bierstadt, of No. 58 Reade Street, have many hundreds of pictures copied by this process, which experts consider superior in clearness and grading of light and shade to any lithographs or photographs. Hundreds of persons have had their pictures reproduced as frequently as desired, while popular paintings and copies of the old masters, albeit in printers' ink, are put within the reach of very limited purses. Not only this: book illustrations of the finer kind, stereoscopic views, and even illuminated business cards are made as cheap or cheaper than by any other process; and specimens of fossils or any illustrations of natural science are reproduced with the exactness of nature itself.

Ever since this marvelously simple process was brought to practical success, both Mr. Albert and Mr. Bierstadt have been experimenting with a view of grafting upon it some improvement which should place chromo-photography as far above other printing in colors as chromo-lithography is in advance of older methods of picture copying. They looked for the solution of the problem to the accepted fact in photographic science that all colors are combinations of three primary colors, namely, red, yellow, and blue. If by any means the sunlight could be so exhibited that only one of these colors at a time should be allowed to act on the sensitive plate, they had penetrated the secret. The experiments made by them exploded several accepted scientific theories. First, Professor Tyndall's assertion that the light of the sun's rays alone affected the sensitized surfaces and produced the picture, was demolished. This was proven by using red, yellow, or blue glass for the screen. Mr. Bierstadt then experimented with various solutions of metals and minerals, and tried several hundreds of these solutions before he found any that produced the desired effects. As these results are not patentable, he is unwilling now to say in which of the color experiments he found success; neither does he know the results of Mr. Albert's experiments. The principle, however, is the same. A colored landscape or portrait is thrown into the camera through a screen, by which all that is yellow and all that is red are excluded. There is thus produced a negative after the Albert-type kind of everything blue in the picture. A screen which absorbs all the colors excepting yellow is the next medium, and the second negative represents the yellow portions of the picture. A screen for red rays completes the third negative. The printing is done just as in the ordinary Albert-type, only red, yellow, or blue inks are used, and each picture is printed three times, once upon each negative.

The process is still far removed from working easily. It has been found beyond the science of experimenters to produce the vivid hues of some of the natural colors. As it stands now, Mr. Bierstadt hopes to be able to copy portraits and other pictures with neutral or subdued tints with entire faithfulness. It cannot yet be adapted to the picturing of natural scenery, because the production of the negatives is much slower than ordinary photographing, and any movement of the object will impair the picture. The same difficulty is met with in taking pictures of living objects. The chief value of the process, as far as it has been matured, is in picturing tapestries, maps or merchandise, or neutral tinted oil pictures; in fact, its chief merit consists in reducing the amount of skill and manual labor, as well as the material and number of processes, so as to bring the cost below that of photo-lithography, while improving the copies in fidelity and brilliancy.—*N. Y. World.*

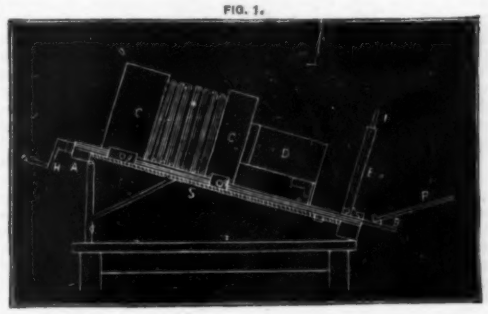
EDWARDS' ENLARGING AND COPYING CAMERA.

AMONG the cameras expressly constructed for this purpose in one by Mr. B. J. Edwards, of Hackney, Eng., which contains several features tending to facilitate the purposes above expressed.

This apparatus consists of a board or frame, of convenient length and width, arranged to carry or support another frame or board sliding upon or under and parallel to the same, this sliding board being worked by an extending screw fixed to the other or principal frame and worked by a handle, the nut of the screw being fixed to the sliding board or frame, which carries an upright piece, frame, or board, to which is affixed the picture or drawing to be copied.

When the picture to be copied consists of a transparent positive or negative photograph, the patentee uses a reflector of white paper, glass, or other suitable material, placed at an angle a few inches behind the transparent picture, and

FIG. 1.



he also uses an adjustable hood or shade to cut off all light from between the transparency and lens of the camera.

The camera may be a separate instrument, or the necessary parts thereof may be attached or fitted to the principal frame, but not so as to interfere with the working of the screw or the sliding frame which carries the object to be copied, and which object is brought into the focus of the lens, and adjustable by means of the screw before described.

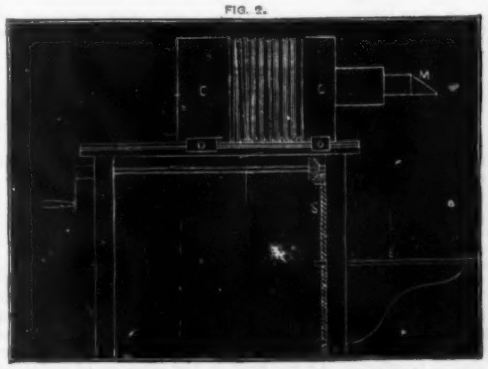
The upright frame or board carrying the drawing to be copied is made to slide both vertically and horizontally at right angles to the sliding frame, in order that it may easily be adjusted to the proper position.

In order to allow a large amount of light from the sky to fall upon the picture to be copied, or upon the reflector, Mr. Edwards raises one end of the apparatus and supports it by a foot or strut at a suitable angle; by this means he considerably reduces or shortens the time of exposure necessary to produce the photographic impression.

By means of the apparatus above described, and especially by means of the screw which adjusts the position or focus of the object to be copied, great facility and accuracy with economy are claimed to be obtained in the photographic reproduction or enlargement of drawings, photographs, or designs.

The invention is more fully explained by the accompanying diagrams, in which Fig. 1 shows a side view of an apparatus for copying or reproducing, by means of photography, pictures, drawings, photographs, or designs, specially intended to facilitate the production and insure the accuracy of such copies or reproduction, whether they are required

FIG. 2.



enlarged or reduced in size, or of the same dimensions as the originals.

A is a base board or frame of convenient length and width, arranged to carry a movable frame or board, B, sliding upon or under and parallel to frame, A. This sliding board is moved by means of an extending screw, S, fixed to the frame, A, and worked by a handle, H. The end of the said screw is fixed to the board, B, which carries an adjustable upright frame or board, E, on which is affixed the picture or drawing to be copied.

When the picture consists of a transparent positive or negative photograph the board E is replaced by the sliding frame or frames, I, which carry the transparency; and a reflector, R, of white paper, glass, or other suitable material, placed at an angle a few inches behind the transparent picture, is also made use of, an adjustable hood or shade, D, being also employed to cut off all the light between the transparency and the lens of the camera, C. The camera is attached to the base board A by means of the clamps, *g*, which slide in grooves, so that the said camera may be drawn out to the required length, when it is kept in position by means of the screws attached to the clamps, *g*, the whole being arranged not to interfere with the working of the screw, S, on the sliding frame, E, which carries the object to be copied, and which is brought into the focus of the lens by means of the adjusting screw, S.

The frame is made to slide vertically and parallel to the sliding frame, E, which is also made to slide across the board or frame B, in order that the object to be copied may be easily adjusted to the proper position.

In order to allow a strong light to fall upon the picture to be copied, or upon the reflector, R, one end of the above-described apparatus is raised by means of a support, F, so as to place it at a suitable angle. By this means the time of exposure necessary to produce the photographic impression is reduced.

When it is desired to make reversed negatives, as used for various photo-mechanical printing, an apparatus similar to the one above described is employed, but arranged as shown in Fig. 2. In this case the sliding board, E, carrying the drawing is made to move vertically by means of the screw, S, worked from the side by beveled wheels or other suitable mechanical arrangements, a reversing prism or mirror, M—the camera, C, being at right angle to the drawing—being also used.

By the use of the apparatus above described, and especially of the screw, S, which adjusts the position or focus of the object to be copied, greater facility, accuracy, and economy are obtained than heretofore.

The special claims in this patent are two:—First—A bed or frame capable of being placed at an angle, and on which is made to slide (by means of a screw) a movable upright frame, which carries the object to be copied, and having at the back a reflector—the above parts being, in combination with a camera, furnished with a hood or shade to cut off all light between the transparency and the lens of the said camera for the purpose set forth, substantially as described and represented in Fig. 1.

Secondly—The movable frame, sliding vertically, and adjusted by means of a screw in combination with a camera and lens fitted with a reversing prism or mirror, for the purpose set forth, substantially as described and represented in Fig. 2.

THE COLLODIO-BROMIDE EMULSION PROCESS.*

I HAVE been asked to give—not certainly a paper on the collodio-bromide emulsion process, but to show my mode of working it. I do so with the greatest reluctance, as the subject has been discussed so often that anything I can say will be just a repetition of what has been said before. It has now been before the photographic world for nearly fourteen years, and during that time has been brought out in many different forms. I refrain from touching on these, as it is sometimes in connection with photographic processes no easy matter to give honor to whom honor is due.

It is now two years since my friend Mr. Aird gave me the formula which I at present work. At that time nobody here thought of working anything but Mr. W. H. Davies' beer and albumen process, with which fine work was done; and when I discovered that I had to make the collodion and, what appeared worse, to test the emulsion, I believe I would never have tried to get over it had not Mr. Aird showed me the whole process.

Well, with his assistance, I am just going to do the same thing here; and from the many inquiries which have been made since I showed the work I had done last season, I know that a few more of my amateur friends, when they see the simplicity of making the plates, the beauty of development, and the certainty of results, will give it a trial. A process which has these advantages has certainly a great deal to recommend it, especially when you read a confession like that which appeared in last week's number of *The British Journal of Photography*, from one of our ablest experimentalists; I refer to Mr. Henry Cooper, who says that with washed emulsions he has, after hundreds of experiments, never been able to depend on plates that have been prepared for more than a few days. Now with this you can keep the plates for a year at all events, and, contrary to the opinion of many, this emulsion will, if properly prepared, keep good for many months. A friend of mine used some that had been kept for a year, and could see no difference in the results from the plates he made and used when the emulsion was new. Now I think this is an advantage that will amply recompense you for the little extra trouble in preparing it.

Professional photographers will, I also hope, be induced to turn their attention to it; for, with a few plates prepared at some time when other business is quiet, they would be ready to do any outdoor work that was wanted—a thing which many of them at present decline to undertake on account of the trouble in taking all the paraphernalia requisite for the usual wet process. I further think the process would be well suited for enlargements. Transparencies, both by contact and in the camera, can be very easily produced by it, and if you have got a good transparency I think any one could, with little expense, have the means of doing enlargements up to (say) 24 × 18 inches.

I may say I have found these plates no more sensitive in their wet state than when used dry; and lately, when trying them wet, I could not by any possibility keep the film on the plate, but when allowed to dry they would stand any amount of washing.

I will now give you a practical illustration, and will begin with the collodion, a stock of which should be kept on hand, as it improves greatly with age, and it is just as easy to make a large as a small quantity. Our manufacture in the present case, however, will be on a small scale—for the sake of convenience say two ounces. For this quantity I will take four drachms of alcohol. We will now have to weigh our bromides; but, unfortunately, the cadmium salt generally sold is not anhydrous, and we therefore take a small quantity into this small evaporating basin and apply heat, which will soon drive off the moisture. Take twelve grains of this and six grains of bromide of ammonium; mix them together, which seems to make them more easily dissolved. Add this to the alcohol, and then put in twelve grains of pyroxyline, which does not require to be any special kind. This will readily dissolve. Then add twelve drachms of ether, and this is your collodion.

We will now emulsify it; and for the two ounces take twenty-four grains of nitrate of silver, put it into a test tube, dissolve in the smallest quantity of water with the aid of heat, and then add four drachms of alcohol. Boil over a spirit lamp; then add this to (say) one and a half ounce of

* A communication to the Edinburgh Photographic Society.

your collodion, shake well, and in a few minutes add the other half ounce of collodion. This method of emulsifying seems to give a more sensitive film and finer deposit than if you had added the silver to the full quantity of collodion.

Now for the testing, which frightens so many. Could not some of you give the experiment a better name? I think if it were just said, "We will see if the emulsion is right," it would be better. Take a little of it in a measure glass, run it round the glass till a thick film forms, then add a little distilled water; break the film well up, and decant a small quantity into two test tubes. To one add two or three drops of a twenty-grain solution of silver; to the other add the same quantity of bromide of potassium. Should either of them be the least milky there is an excess of the opposite material to that with which it was tested, that is, if the tube be milky to which the silver was added there would be excess of bromide, for which the remedy is to add a little more silver. If the tube to which the bromide was added be milky then you have excess of silver, and require to add a little more collodion. Should the tubes remain clear then you may consider you have your emulsion in its most sensitive state. It should now stand for twenty-four hours at least, during which time you can give the bottle an occasional shaking. Filter through linen, and you are now ready for preparing a batch of plates.

Keep always a supply of clean plates in your box. I prepare mine by soaking them in very dilute sulphuric acid. If they have been varnished put them in a solution of warm water and washing soda, which will soon take the film off; then rinse in cold water, and put them into the acid. When wanted I take them into the washing-house, put the plate on the bottom of a tub, give it a good scrub with a hard brush, rinse with water, drip, and then flow it over with albumen. When dry they are ready for use.

You can now coat the plate with the emulsion. This must be done slowly, as if you tilt the plate suddenly, the same as you might do with wet collodion, there would be a mark made at the top of the plate. Allow it to set well; then plunge it into a dish of water. Take as large a vessel as you can get, and you can then go on coating the plates till your vessel is full; but they should remain in this till greasiness disappears. Take your first coated plate out, drain, and flow over with preservative. Almost any of the usual preservatives will do, but I use bitter beer. It needs no alcohol to moisten the plate before development, and works nice and clean without any restrainer in the developer. You have only to flow it over once or twice, and put it aside to dry.

Like most dry plates these require a backing of some coloring matter to prevent blurring—say a little burnt sienna, to which has been added a little gum to make it adhere, as also a small quantity of alcohol, which allows it to dry quickly as well as helps it to keep.

The plate is now ready for exposure; and although these are, perhaps, not the most sensitive plates you can get, yet my impression is that as you increase the rapidity you also increase the uncertainty. I have two plates with me to develop that were exposed yesterday with Dallmeyer's 8½×6½ rapid rectilinear, stop $\frac{1}{16}$ focal length, for one and a quarter minute, and I am quite sure they will be fully exposed.

The development of these plates is, you will see, so simple and beautiful that I do not think any of you will envy those who go in for some of the new processes, where they have almost to work in darkness, and turn up the back of their plates with the expectation of seeing a "ghost." In most cases you only require two solutions in developing—one a saturated solution of carbonate of ammonia, and the other a sixty-grain solution of pyro. in alcohol.

I will now try and develop this plate. First wipe off the backing with a wet sponge; moisten the film with water, or rather wash it till all greasiness disappears. Now take a quantity of the ammonia solution, to which add a few drops from the pyro. bottle; and then flow it with a good sweep over the plate. The image will soon appear, and will rapidly gain in intensity as well as in detail. If the plate be properly exposed it will require nothing further; but should all detail come out without sufficient density, owing to the plate being over-exposed, you had better wash and apply the usual acid pyro. and silver intensifier, not forgetting to swill the plate with weak acetic acid, to neutralize the ammonia that may be left in the plate, before applying the intensifier. You can fix with hypo. or cyanide, but I prefer hypo.

ALEXANDER MATHISON.

DIRECT INK PRINTING FROM GLASS NEGATIVES.

By HANS BRAND.

To make negatives capable of being printed from they must be coated with a solution of chromatized gelatine, but only after they are perfectly dry. By this means a layer of chromatized gelatine is deposited over the collodion film. But it is well known that when such negatives are exposed in diffused light the lines become broader than they should be, because the light, even with thin films, can act sideways. In order to obviate this, I tried to form a film of chromatized gelatine in that of the collodion negative, and I was fortunate enough to be completely successful. The method that I adopted was to fix the negative immediately it was taken, without first drying, then to wash it with water, and while still wet to immerse it in a dilute solution of chromatized gelatine. When dry, the surface was quite dull, without any sign of gelatine upon it; the collodion film had, notwithstanding, absorbed sufficient chromate and gelatine to be capable of printing from after exposure.

The best method of obtaining these plates with what may be called a typographical collodion film is as follows: First take an ordinary, but not an intense, negative on an albumenized plate-glass plate, fix it at once, wash it, and then plunge it into the gelatine solution, which should be prepared in the following way: 4·5 parts of gelatine are allowed to soak and swell up in water, the excess of fluid is poured off, and the remaining gelatine dissolved in 50 parts of distilled water; then a solution of 5·5 parts of ammonium bichromate in 100 parts of water are added, and the whole is heated to 75° C. In this bath the plate must remain for about five minutes. When large plates are used, the solution may be flowed over them, taking care to wash them rapidly with warm water beforehand. In this case, too, it is necessary to repeat the coating with chromatized gelatine several times. After the plate has taken up a sufficient quantity of the solution it is placed in a horizontal position and heated over a spirit lamp. Should fumes come off, the plate must be held upright for a minute or two, and again laid horizontal and further heated until it is quite dry. It should not be made hotter than the hand can bear when passed over the reverse side.

For negatives of this kind the time of exposure cannot be accurately determined by the eye, nor can it be measured by the ordinary photometer. I overcame this difficulty by first well wiping the prepared negative on the reverse side, and then laying on the film side a small piece of albumenized or chromatized paper, exposing the whole in a frame on the reverse side to the light. By aid of this simple expedient, the action of the rays of light can easily be watched, so that places which are too dark can be covered, and all the other artifices used which are common in silver printing. Commonly a black support is employed, to avoid the reflection of light, but in this process, as I have described it, reflection need not be feared, notwithstanding the white albumenized paper, for the silver chloride absorbs all the rays of light.

As soon as all the finest lines of the image are distinctly visible, the ammonium chromate must be washed out by dipping the plate into cold water; the plate can then be dried and placed in the hands of the printer. The finest rollers must be used for printing. When the plate is damped I would recommend that a little gum arabic be dabbed on the edge and rubbed over the surface of the picture. As regards the production of the negative, I should observe that it is not every collodion which will take up the chromatized gelatine; there are collodions which will not absorb the gelatine at all, so that a layer of chromatized gelatine merely is obtained on that of the collodion. The lithium collodion, prepared by Kurz, of Wernigerode, is best adapted for this purpose. Probably the lithium salt in this collodion plays no unimportant part in the reaction, but I have not had an opportunity of making experiments on this point.*

ON THE USE OF CHALK IN DYEING WOOL.

FEW dyers know how important a part chalk may be made to play in dyeing wool, and how by its use many inconveniences with their resulting defects may be avoided. All dyers are aware that dark wool, and cloth to be dyed black, which require the use of a considerable amount of copperas (sulphate of iron), acquire a hard and brittle feel, which in the yarn, especially the higher numbers, is accompanied by a difficulty to felt and a loss of strength. The cause of this is the sulphuric acid, which in the free state is partly contained in the copperas, and which is partly set free by the decomposition of the latter, when the iron combines with the dyestuff. The injury is a double one, for not only does the acid act upon the wool, but it also raises the temperature of the bath to a point above that which is of the greatest advantage for the dyeing operation. These practical difficulties can be avoided by adding to the copperas a certain quantity of chalk (carbonate of lime), which in the first instance neutralizes the free sulphuric acid, of which no commercial copperas is devoid, and which is therefore present in the bath. That part of the chalk which remains after this reaction being in excess subsequently as the dyeing proceeds, neutralizes the acid liberated during the operation by the combination of the iron in the copperas with the logwood or other dyestuff.

Thus the bath is always kept in its normal condition, and is always neutral. As chalk itself is a neutral substance, any surplus of it in the bath remains without action and does consequently no harm. Thus also is explained why, in applying chalk, less copperas is used, as the free sulphuric acid must always militate against the combination of the iron with the logwood in the fiber; but if the acid is taken up as soon as it is liberated, the iron acts to better advantage, and consequently less may be employed.

A good proportion is one part chalk to four parts copperas; if the latter should be very acid, a larger amount of the former ingredient must be taken. When dyeing cloth it is advisable to dissolve the copperas by itself and then to add the chalk; this is necessary, as the carbonic acid, when liberated freely, throws up large bubbles which interfere with the dyeing of the material.

Both wool and cloth treated in this manner turn out much softer, and undergo the subsequent operations with much greater facility.

Not only in the dyeing, but also in the extraction or boiling the logwood, is it of advantage to use chalk, for a water which contains carbonic acid obtains the dyestuff with greater ease and in larger quantity from the wood than does a water devoid of this acid. It is therefore advisable, when using a water which is poor in carbonic acid, to add at the beginning of the operation a little chalk, and likewise during the process of boiling a little sulphuric acid for the purpose of liberating the carbonic acid. For the accomplishment of this good, proportion out three parts chalk to one part sulphuric acid. Should the liquid turn yellow, it indicates the presence of too much acid, but this is easily remedied by the addition of some more chalk until the liquid is again the normal red. As regards the additional expense, ground chalk is so low priced that its cost is more than recouped by the better and more complete extraction of the dyestuff.—*Textile Manufacturer.*

MANGANESE AND CHROME BLUES.

M. GASTON BONG, in the *Bul. de la Société Chim. de Paris*, says this blue is obtained on igniting silica, and any compound of manganese, with baryta, or a mixture of soda and lime in an oxidizing atmosphere. Either of the following mixtures may be used:

Silica	3 or	Silica or kaolin	3 or 2
Soda-ash	6 "	Barium nitrate	8
Carb. of lime (free from iron)	5 "	Oxide of manganese (free from iron)	3

The proportion of manganese affects the intensity of the blue, but not its tone. By increasing the proportion of alkali or silica, a green or a violet tone is produced. The use of potassa does not give good results. The ignition should be effected at a red heat, in the absence of reducing gases. These facts lead to a very delicate process for detecting the presence of manganese, especially in earthy substances. If to one of the above mixtures, made of materials free from manganese, any substance containing a trace of that element is added, a blue color appears on ignition. The same author obtains a chrome blue with the following materials, which are intimately mixed and strongly calcined with free access of air:

Boric acid	15 parts.
Alumina	15 "
Carbonate of magnesia	20 "
Chromate of baryta	2 "

* Besides the well known fact that the compounds of the halogens with the metals have a considerable effect in producing a more or less liquid collodion, it is probable that in the case under consideration the quality of the pyroxyline is a factor of some importance.—Editor of the *Photographische Correspondenz.*

BLUE ALIZARIN.

M. PRUD'HOMME laid before the Société Industrielle de Mulhouse samples of goods dyed and printed with a new product lately offered in the market by the Ludwigshafen Alizarin Works, under the name of "Blue Alizarin." This color was discovered by M. Prud'homme among the derivatives of monitro-alizarin, but was first isolated and obtained on a commercial scale by M. Brunck. It sublimes in black crystals like those of indigo, giving off violet-red vapors. It is also insoluble in water, sparingly soluble in alcohol, but more readily soluble in acetic acid. In alkalies it dissolves with a blue color. Its barytic and calcic salts are a greenish blue. Concentrated acids dissolve it with a fine red color. Blue alizarin does not dye below 70°, and the process should be pushed to a boil, and is facilitated by adding to the bath either a little soap, or oil such as is used in dyeing Turkey reds. The shades produced with the different mordants are: with alumina, a violet-blue; iron, a greenish blue; chrome, a violet; and tin, a reddish violet. The most useful mordants in printing are ammonium or potassium ferrocyanide, and chromium acetate. By steaming, a color of one part alizarin blue with four of thickening yields shades like deep indigo blues, and as with red alizarin the shades are brighter, and fuller upon cloth prepared as for Turkey reds. Goods dyed or printed with alizarin blue resist soap, dilute acids, chlorine, and light, very satisfactorily. Wool can be dyed without mordant in an acid bath. One of the most interesting peculiarities of blue alizarin, pointed out by M. Prud'homme, is that it becomes soluble in an alkaline solution, being reduced like indigo. The vat is rose-colored, and is covered with a greenish blue scum. Being almost insoluble in water, it is fixed on the fiber as it becomes re-oxidized by the air, and produces blue shades like those of indigo.—*Moniteur Scientifique.*

DYES AND COLORS.

THE light of Swedish matches is found sufficiently white for comparing colors.

Lake Colors are now prepared by dissolving artificial alizarin in a caustic alkali, adding an alkaline aluminate, and precipitating by the addition of a weak acid or an ammoniacal salt.

Fixation of Eosin upon Cotton.—E. Apelt.—The author shows that the best mordant for eosin upon cotton is acetate of alumina, the pieces or yarns being subsequently taken through a chalk-bath; the color-bath should contain a little acetic acid. Precipitated silicic acid and other porous bodies are useless.

Rose Bengale.—This is a new dye of a beautiful blue-red color, a substitution product of fluorescein. Cotton is prepared for its reception by treatment with an emulsive oil, as for Turkey-red dyeing, and subsequent steeping, when dry, in acetate of alumina, a little of which is also added to the color-bath.

Chrome Residues.—Residues containing chromic oxide derived from the production of potassium chromate are of frequent occurrence, *e.g.*, in the manufacture of artificial alizarin. Wagner proposes to treat such with a mixture of soda-lye and potassium ferro-cyanide, and thus effect the re-oxidation of the chrome. Or chromic oxide may be heated with soda-lye, and bromine may be added in small successive portions till all chromic oxide has disappeared and the liquid becomes clear and yellow.

Caulin is the name given by a patentee to the coloring matter of red cabbage, which he proposes to extract with boiling water, and to precipitate with certain metallic salts and oxides, using the lakes thus obtained in the arts.

Silicate of Soda is recommended for preparing unbleached cottons for the indigo vat.—*Reimann's Färber Zeitung.*

PORTLAND CEMENT.—Portland cement is made near Rochester, England, in this way: Gray chalk is intimately mixed with one fourth of its weight of clay in a pug mill supplied with warm water, and is then run off into a settling-pond, where the superfluous water is removed. The sediment is dried on a floor specially constructed and provided with flues, then burned in a kiln, and lastly ground between millstones.

SEAL BROWN.—To 100 lbs. wool, take 14 lbs. logwood, 50 lbs. fustic. Boil in a bag. Take out of the bag, and add to the bath 5 lbs. of sumac, 40 lbs. of camwood, 5 lbs. of madder. Let it boil for fifteen minutes, cool the dye, enter the wool, and let it boil for one hour, after which darken with 3 lbs. of copperas. Let it boil twenty minutes longer.

FAST BLACK ON WOOL.—To 30 lbs. of wool, dissolve 1 lb. of bichromate of potash, ½ lb. of blue vitriol, ½ lb. of tartar, ¼ lb. of sulphuric acid. Prepare the wool in this solution for one hour. In fresh water boil in a bag for one hour 14 lbs. of logwood, 1 lb. of camwood. Cool the dye, enter the wool, handle it well, and let it boil for one hour.

SCARLET ON COTTON.—20 lbs. yarns: Steep the yarn in 4 lbs. sumac over night, then spirit with muriate of tin at two degrees Twaddel. Finish off with 2 lbs. peachwood, 3 lbs. quercitron bark. Have the baths lukewarm, and give nine turns in each bath. Wash off. If yellower shades are wanted, use less of the peachwood and more of the bark, according to shade wanted.

LIGHT BROWN-RED ON CLEAN WOOL (60 KILOGRAMMES).—The wool is boiled two hours in a bath with 2 kilogrammes chromate of potash, and 1 kilogramme bitartrate of potassa, and completed in a fresh bath with 4 kilogrammes fustic extract, 20 kilogrammes sandal, 2 kilogrammes carthamine, 2 kilogrammes sumac, 1 kilogramme logwood dust.

SCARLET ON WOOL.—No. 2.—125 lbs. foreign wool, 15 lbs. cochineal, 4 lbs. flavine, 12 lbs. red tartar, 4 quarts of nitromuriate of tin. Boil one and one-half hours.

ORANGE ON CLEAN WOOL (60 KILOGRAMMES).—The wool is boiled for one hour in 8 kilogrammes of extract of quercitron, 6 kilogrammes of bitartrate of potassa, 1¼ kilogrammes of cochineal, and 3 kilogrammes of sulphate of tin.

IT is proposed to extract formic acid and an especial oil, caloptine, from locusts and grasshoppers.

CONTRIBUTIONS TO BLOWPIPE CHEMISTRY

FIRST PAPER.—NEW BLOWPIPE BELLOWS.*

By P. CASAMAJOR.

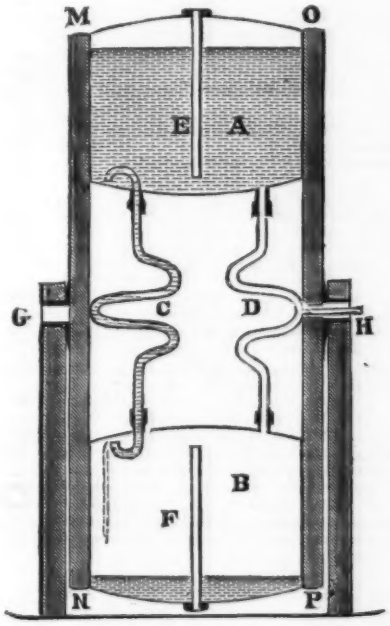
THIS apparatus works by water pressure. It is formed of two drums, A and B (see Fig. 1), connected by a pipe, C, open at both ends, which I will call the *water-pipe*. Another pipe, D, which I will call the *outlet air pipe*, is connected with both drums, and serves to carry off the compressed air from the lower drum to the nozzle of the blowpipe. In addition to these, the drum A is provided with a tube, E, and the drum B with a tube, F, which I will call the *inlet air-pipes*. The function of these is to admit air into the upper drum.

The upper and lower drums are firmly fixed on two upright pieces of wood, M N and O P, which are provided with journals, G and H, which turn in bearings attached to a frame. One of the journals, H, is hollow, and through it passes a tube, soldered to pipe D, which serves to carry the air of the lower drum to the blowpipe.

If we suppose that the upper portion of the pipe D and the pipe F are closed, while the lower part of the pipe D and the pipe E are open, and if, moreover, we suppose that the upper drum, A, is full of water, while the lower drum, B, is full of air, we may see that the water in A will run down the water-pipe, C, and fall into the lower drum. This produces pressure in this drum, which drives the air in it to the blowpipe, through the lower part of the pipe D. As the water descends to the lower drum, air is admitted to the upper one through the inlet air-pipe, E, so that finally the lower drum becomes full of water and the upper one full of air. We may then turn the drums on their journals, G H, so as to place the drum B above the drum A. If now we close the inlet air-pipe of the lower drum and the upper portion of the pipe D, while we open the inlet air-pipe F of drum B and the lower part of the outlet air-pipe, D, the water of B, as it descends into A, will drive out the air of this drum to the blowpipe, through the tube D. When this action is over, the apparatus may again be reversed with the same result as before, and so on indefinitely.

It may be noticed, in Fig. 1, that the tubes C and D are curved instead of being straight. The object of these curves is to prevent the expansions and contractions of these tubes from injuring the drums, as these are held apart by the pieces of wood, M N and O P, whose longitudinal expansions and contractions are insignificant when compared to those of the tubes, which are of metal. It may also be noticed that the

Fig.1.



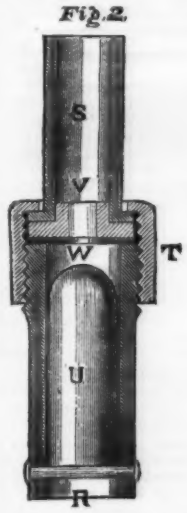
water-pipe, C, terminates at each end by a curved portion, the object of which is to keep the lower part of this pipe full of water when the water runs down, to prevent the air of the lower drum from ascending through this pipe into the upper drum.

I have mentioned that it is essential for the proper working of this apparatus that the upper inlet air-pipe and the lower portion of the outlet air-pipe, D, should be left open while the lower inlet air-pipe and the upper part of the outlet air-pipe, D, should be tightly closed. It would be possible to accomplish these alternate openings and closings of air-pipes by providing each inlet air pipe with a cock, and the outlet air-pipe, D, with two cocks, each placed between one of the drums and the middle of the pipe D. By alternately opening and closing these cocks with the hand, the desired object would be accomplished, but it has been found more convenient to use valves, which open and close automatically. As these valves must close very tightly, and with considerable pressure, I use the arrangement shown in Fig. 2, which works with entire satisfaction.

In Fig. 1, it may be noticed that the pipes C, D, E, F are enlarged at the portions at which they are inserted in the drums. These enlargements correspond to screw couplings, which, in the case of the water-pipe, C, and the outlet air-pipe, D, consist of two tubes, R and S, of which R is provided with a screw. A nut, T, works in the screw of the tube R, and this nut is provided with a shoulder, which presses down on the rim of the tube S, so that by turning this nut the tubes R and S are brought tightly together. Between these two tubes, in the case of the water-pipe, C, there is a washer of rubber or leather to keep the joint from leaking. In the case of the outlet air-pipe, D, the arrangement adopted is shown in Fig. 2. Between the tubes R and S there is a cork washer, V,† cut as shown in the figure, so that part of it enters in the tube S, while another portion is pressed between the tube R and the rim of the tube S. To the face of this cork washer, which is turned toward R, is stitched a soft rubber washer, W, about $\frac{1}{16}$ of an inch thick, its diameter being the same as that of the wide part of V. This rubber washer has a hole in its center about $\frac{1}{16}$ of an inch diameter, while the cork washer has a hole of $\frac{3}{8}$ of an inch diameter.

At the end of the tube R furthest from the screw a wire is placed in the diameter of the tube and riveted in its place. This wire is to prevent the weight, U, from falling further down, when placed as shown in the Fig. 2. This weight is cylindrical, with a hemispherical head at the end, which is

Fig.2.



turned toward the washer W. The diameter of the weight is slightly smaller than that of the interior of the tube R, that it may move in this tube with ease. The rounded end of this weight is polished, but the cylindrical portion may remain quite rough. The cylindrical portion has two deep grooves, to let the air pass freely from below the weight to the space above it. The function of this cylindrical weight is to close the opening left in the thin rubber washer, W. This is easily understood by reversing Fig. 2, so that the tube R shall be above the tube S, in which case the weight U slips down and closes the opening in the thin rubber washer. The cylindrical weight U is made of an alloy of lead and antimony, which gives sufficient density, combined with hardness. The length of each cylindrical weight is 1¾ inches, the diameter being ½ inch. Each one weighs 3 ounces.

An indispensable condition for the proper working of this valve is that the opening in the rubber washer W shall be in the axis of the tube R, as otherwise weight U will not close this opening perfectly. It is to insure this condition that a portion of the cork washer V has been given a smaller diameter, that it may be inserted in the tube S, and be kept from moving sideways. By attaching the thin rubber washer to this cork washer by a few stitches of thread, the rubber washer is kept immovable in its proper place.

The arrangement shown in Fig. 2 is, as I have said, the one adopted at each end of the outlet air-pipe, D, the tube R being soldered on the drum. In the case of the inlet air-pipes, E and F, the tube S has been suppressed, and the cork washer is of sufficient diameter to fit in the nut T. The rubber washer is stitched on its under side, as before.

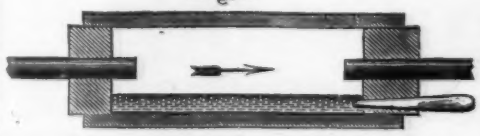
Constant Pressure.—By referring to Fig. 1, we may notice that the inlet air-pipes, E and F, are prolonged to nearly the bottom of their respective drums The object of lengthening these pipes is to insure constant pressure to the blast.

In the positions of things shown in Fig. 1, the pipe F is closed, but the pipe E is open, and it may be seen that the drum A is equivalent to a *Mariotte's flask*, and the water pressure is represented by the distance from the lowest part of E to the outlet of the water-pipe. In the apparatus which I now exhibit before the society this height is equal to 15 inches, equivalent to nearly 10 ounces pressure per square inch. Each drum in this apparatus has a diameter of 10 inches and a height of 8 inches.

The duration of the blast depends on the bore of the nozzle. For the small bore used in qualitative blowpipe tests, the drums have to be reversed every 35 minutes. For the bore used in Plattner's quantitative assays, the duration is 20 minutes. For a large flame, fit for glass blowing, using a bore equal to No. 22 wire gauge, the duration is 12 minutes.

Spring-catch.—A necessary feature of this apparatus is a spring-catch, to hold the drums in position while working. Without it, the upper drum when full of water would not

Fig.3.



remain above the lower. This catch is freed by pressing on a button when the drums are to be reversed. The operation of reversing takes about a second. As a spring-catch is very easy to make, no detail is given of it in the figure.

Water-trap.—When there is too much water in the drums, and under other conditions, which I have not been able to determine, a little water sputters up with the air, and finds its way to the blowpipe. To prevent this, a trap is conveniently made, as in Fig. 3, with a glass tube tightly closed at each end by a rubber cork. A tube enters through the middle of each cork, one for the ingress of air from the lower drum, and the other for its egress to the blowpipe. One of the corks is provided with another hole, near its circumference, which may be conveniently closed with a plug of any hard substance, and water may be let out from time to time, by removing this plug. In the bellows I use, the glass tube shown in Fig. 3 is placed in the hollow journal, H.

* Read before the American Chemical Society, Feb. 7, 1878.

† Since this paper was written, I have found that cork and India-rubber are not sufficiently durable. The piece V should be made of hard wood or metal, and the washer W of leather. V should be perforated to allow W to be stitched on it, and there should be another leather washer between V and the pipe S.

ABSORPTION OF CARBONIC OXIDE.

GRÉHANT has performed some experiments in order to ascertain what proportion of this gas must be mingled with the atmosphere before it is capable of being absorbed by a living animal. Details of a single experiment will illustrate the method employed; 30 cc. of blood were drawn from the superior cava of a healthy dog; the animal was then made to breathe air containing $\frac{1}{100}$ of carbonic oxide for half an hour, and at the close of this period a second sample of blood was drawn. After another thirty minutes, during which pure air was supplied, a third specimen of blood was taken. The three samples of blood were defibrinated and shaken with oxygen; the gases contained in them were then extracted *in vacuo* and subjected to quantitative analysis. The first yielded 28.3 cc. of oxygen per cent.; the second, 14.9 cc.; the third, 20.3 cc. Inasmuch as the hæmoglobin of the red corpuscles takes up oxygen and carbonic oxide in the same proportions by volume, the blood must have absorbed 13.4 cc. per cent. of the latter gas during the period of inhalation, and given up 5.4 cc. per cent. during the subsequent half hour. The general conclusion at which Gréhant arrives is that an animal breathing an atmosphere containing only $\frac{1}{200}$ of carbonic oxide will absorb enough of this gas in thirty minutes to incapacitate one half of the red corpuscles in its blood for taking up oxygen. If the atmosphere contain $\frac{1}{400}$ of the gas, only one quarter of the red corpuscles will be rendered functionally impotent.—*Comptes Rendus.*

DETERMINATION OF VAPOR-DENSITIES.—V. MEYER.—The author describes a greatly simplified apparatus for these determinations, which is essentially the same as that lately described by him to be used with Wood's metal, the latter being replaced, however, by mercury, and the sulphur vapors by those of water, aniline, or ethylbenzoate. A U-tube, open at one end, contains the substance to be experimented upon, and is filled with mercury. It is then hung in an atmosphere consisting of the vapors of one of the above-mentioned liquids until the mercury ceases to flow out. The weight of the mercury which has been ejected, the height of the mercury column in the side tube, temperature, and pressure supply the necessary data for determining the density.

FOOD.

PROF. LESGAFT lately delivered an interesting lecture before the Technical Society, Russia, on the *modus operandi* of baking biscuits and the preparation of conserves. The experiments of the lecturer proved that in order to support the human organism in good health the proportion between the nitrogen and carbon of the food must be as 1 : 4·5, so that 750 grms. of solid food are quite sufficient for daily nourishment. This quantity, according to his experiments, must contain—

Albuminous matters	150 grms.
Fat	100 "
Hydrocarbons	475 "
Various salts	25 "

Prof. Lesgaft believes that a man at work requires not less than 600 grms. of meat.

FORMIC ACID.—V. MERZ and F. TIBIRICÁ.—The authors prepare this acid by conducting a stream of CO over soda-lime at 200° to 250°. The gas is rapidly absorbed, forming CHOONa, and the process can be used for the technical preparation of the acid as well as for a lecture experiment to show the direct formation of organic substances from inorganic.

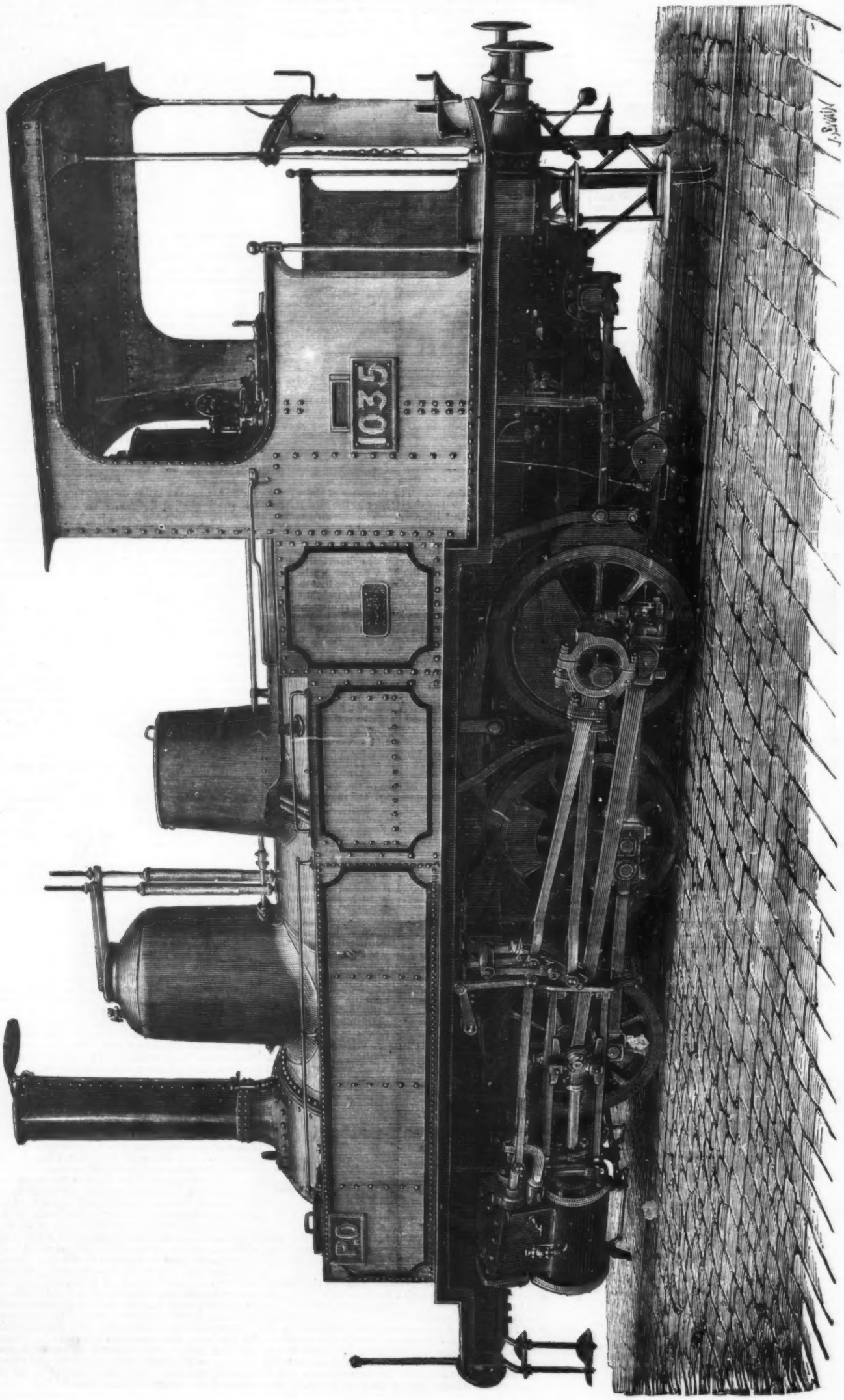
HEARING BY THE TEETH.

To the Editor of the Scientific American:

IN the issue of the SCIENTIFIC AMERICAN for June 1 was an article entitled "Hearing through Teeth," giving an account of a workman in Springfield, Mass., ascertaining if water were passing through a pipe by placing his teeth upon it. Sound can undoubtedly be thus conveyed, and that fact, I think, can be utilized in conveying sounds to the deaf and dumb. Where the defect in such cases is caused by *internal* malformation probably no means would convey apprehension of sound, but where, as is often the case, deafness arises merely from defect in the *external* organizations only, hearing could probably be supplied through the teeth when the ears conveyed no sound. Harriet Martineau mentioned the case of a deaf and dumb boy who derived great enjoyment by hearing a watch which he held in his mouth tick. Many years ago a daughter of mine attended a school in Philadelphia which included among its scholars two sisters, one of whom was deaf and dumb, and was such a great favorite with the other scholars that all the pupils learned the deaf and dumb language in order to converse with her. The father of one of the pupils invited all the school to an excursion to Fairmount Park. After wandering about the grounds until fatigued the party adjourned to the hotel to rest, but the gentleman, not wishing to make a mere convenience of the house without returning some compensation, ordered that all the party should be supplied with sherry-cobblers, which were furnished, each tumbler accompanied with a small glass tube wherewith to draw the liquid into the mouth, when, all at once, the deaf and dumb girl sprang into the middle of the room, laughing vociferously, and pointing alternately to her ears and to the glass in her hand. The other girls eagerly gathered around her to learn the cause of her excitement, when, as soon as she was sufficiently composed, she informed them that when her cobbler was nearly drunk up, and the liquid became so low that air entered the lower end of the tube at the same time with it, she distinctly heard the gurgling produced in the tube, the first sound she had ever heard in her life. I subsequently tried experiments of hearing by the teeth. I held one end of a long pine rod, 50 feet in length, in my mouth, and I could distinctly hear the scratching of a pin at the other end, although my ear could not perceive it at all. As the vibration of a stringed instrument of music is especially capable of conveying sounds in this manner, I thought what exquisite enjoyment might be imparted to a deaf and dumb person by having a silver or metal bracket affixed to the end of a piano, so that a deaf and dumb person could hold it in her or his mouth, and so be enabled to hear the music.

Another thing in connection with this principle of hearing by the teeth has suggested itself to me. Remarkable success has lately been achieved in instructing deaf mutes to utter oral sounds and engage in oral conversation by teaching them to watch the muscles of the persons with whom they converse. I have thought that, either in this instruction or in conversation, in connection with this medium of hearing by the teeth, the *telephone* might perhaps find another field of useful operation.

W. B. W.



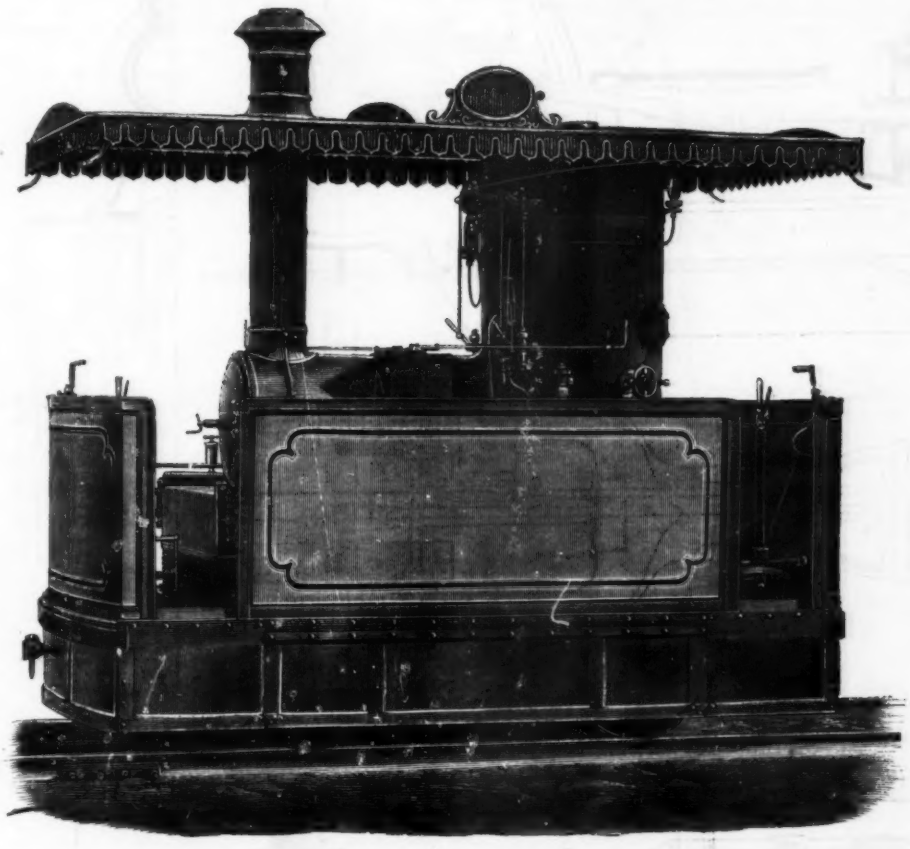
THE PARIS EXHIBITION.—TANK LOCOMOTIVE, PARIS AND ORLEANS RAILWAY.—MM. CAIL ET CIE., PARIS, ENGINEERS.

THE PARIS EXHIBITION.

WE give four illustrations of notable engines, of which two are of the locomotive type; the others show a horizontal condensing engine. We are indebted to our London contemporary, the *Engineer*, for these engravings and the accompanying particulars.

BROWN'S TRAMWAY LOCOMOTIVE.

This tramway engine is exhibited at Paris by the Société Suisse, Winterthur. It has been constructed from the designs of Mr. Brown, the manager. The reversing gear—Mr. Brown's latest patent—in connection with the brakes gives full command over the action of the engine, and will stop or reverse the car almost instantaneously. Owing to the smoke consuming arrangement there is no escape of smoke or gas. The stack is so constructed that the exhaust is almost inaudible, and only visible in very cold weather. The fire-box, boiler and steam space are so constructed, the former with sloping bars, that stoking and feeding are only necessary at intervals of from one and a half to two hours. The cylinders, valve gear, etc., are all placed above the platform and outside the frames, so that they are protected from mud and dust, and easily kept clean and attended to. The consumption of coke is about 18 lbs. per hour. The driver is always at the head of the engine, whichever way it is running, so that he has even a better lookout than with horses, the regulator, brakes and reversing gear being worked from either end. It has been found in practice that horses are less frightened by the machinery when the same is exposed and the driver visible, than when the whole is inclosed in a cab. The engine is built for ascending gradients of 1 in 18, and passing round curves of 20 m. radius—66 ft.—or even, if necessary, 43 ft. radius. The bearings are on a system of spiral springs with three points of contact, so that a very steady motion is obtained. The valve chests are on the under side of the cylinders, so that the latter discharge themselves of any condensed water at each stroke, without cocks. In addition to this, the exhaust is led into a separate apparatus, whereby the ejection of sooty water through the chimney is rendered impossible. The motion from the cylinders to the wheels and coupling rods is communicated by means of a rocking beam, by which arrangement the cylinders and gear are protected, and the further advantage obtained that the wheels are constructed with counterbalances, and the "boxing" motion of the engine obviated. The coupling is arranged for pushing or drawing the carriages. The boiler is of steel plate, tested to a working pressure of 15 atmospheres, partly horizontal and partly vertical, and of such proportions that an abnormal difference in the water level can take place without damage, and if fed from every one and a half to two hours the attention of the driver need not be withdrawn from his work to watch his gauge. The general proportions of the engine are as follows: weight of engine, empty, 6 tons 6 cwt.; ditto, full, 7 tons 12 cwt.; water in boiler, 22½ cubic feet; ditto in tank, 16 cubic feet; coke, 4 cwt.; diameter of wheels, 26¾ inches; maximum length of engine, 11 feet 9 inches; ditto width, 4 feet 3 inches; ditto height, 10 feet 6 inches; wheel base, 4 feet 10½ inches; maximum pressure in boiler, 15 atmospheres.



THE PARIS EXHIBITION.—SWISS TRAMWAY LOCOMOTIVE.

GOODS ENGINE, PARIS AND ORLEANS RAILWAY.

OUR illustration of the locomotive engine exhibited at Paris shows a six-wheeled coupled tank goods engine with outside cylinders, constructed by Messrs. Cail & Co., of Paris. As will be seen, there is no striking peculiarity or novelty of construction to distinguish it from the general type of French locomotives. The leading dimensions, says the *Engineer*, are as follows:

Diameter of cylinder	15¾ ins.
Length of stroke	18 ins.
Diameter of wheels	3 ft. 6 ins.
Area of grate surface	9½ sq. ft.
Number of tubes	167
Diameter of tubes	1¾ in.
Length of tubes	11 ft. 4 ins.
Heating surface of fire-box	43·50 sq. ft.
" " tubes	806·60 "
Total	850·10 sq. ft.
Capacity of boiler:	
Water	93·41 cubic ft.
Steam	41·37 "
Capacity of tank	70·60 "
Coal bunker	35·30 "
Weight of engine	26¼ tons empty.
" " "	32½ tons full.
Pressure of steam	120 lbs.

PORTABLE MINING ENGINE.

We give a perspective view of a 30-horse semi-portable winding engine constructed by Messrs. J. Fowler & Co., of Leeds, and exhibited by them at the Paris Exhibition. The engine is of a type which Messrs. Fowler have made for some years, but it includes several improvements of detail, and is of particularly neat design, as our engraving will show.

The engine has a pair of cylinders 12 inches in diameter, with 14 inch stroke, these being so placed that they project beyond the front of the smoke-box, a cover being provided at the top of the valve chest for ready access to the valves. The crank shaft is geared 1 to 5 to the winding drum shaft, the gearing being of very strong proportions, as are also all the working parts.

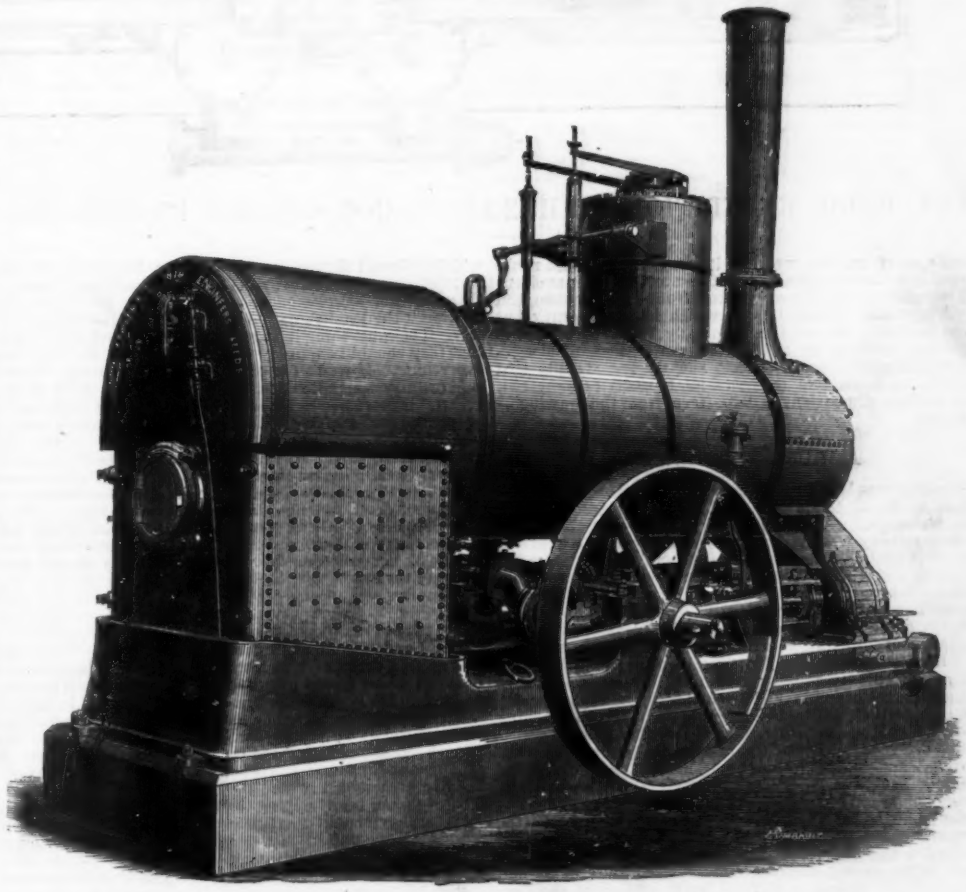
The boiler has a firebox 3 feet 9 inches long by 4 feet 4 inches wide, and the barrel contains 41 tubes 3 inches in diameter and 8 feet 9 inches long between tube plates. A capacious dome is provided at the top of the barrel. The engine bed-plate, it will be noticed, is prolonged to form the ashpit, and is fitted with a damper door at the firebox end. The frame is very massive, and its outline is particularly neat. The length and width of the engine and boiler over all are 17 feet and 8 feet 6 inches respectively, and the whole is a thoroughly substantial job.—*Engineering.*

100-H. P. HORIZONTAL CONDENSING ENGINE.

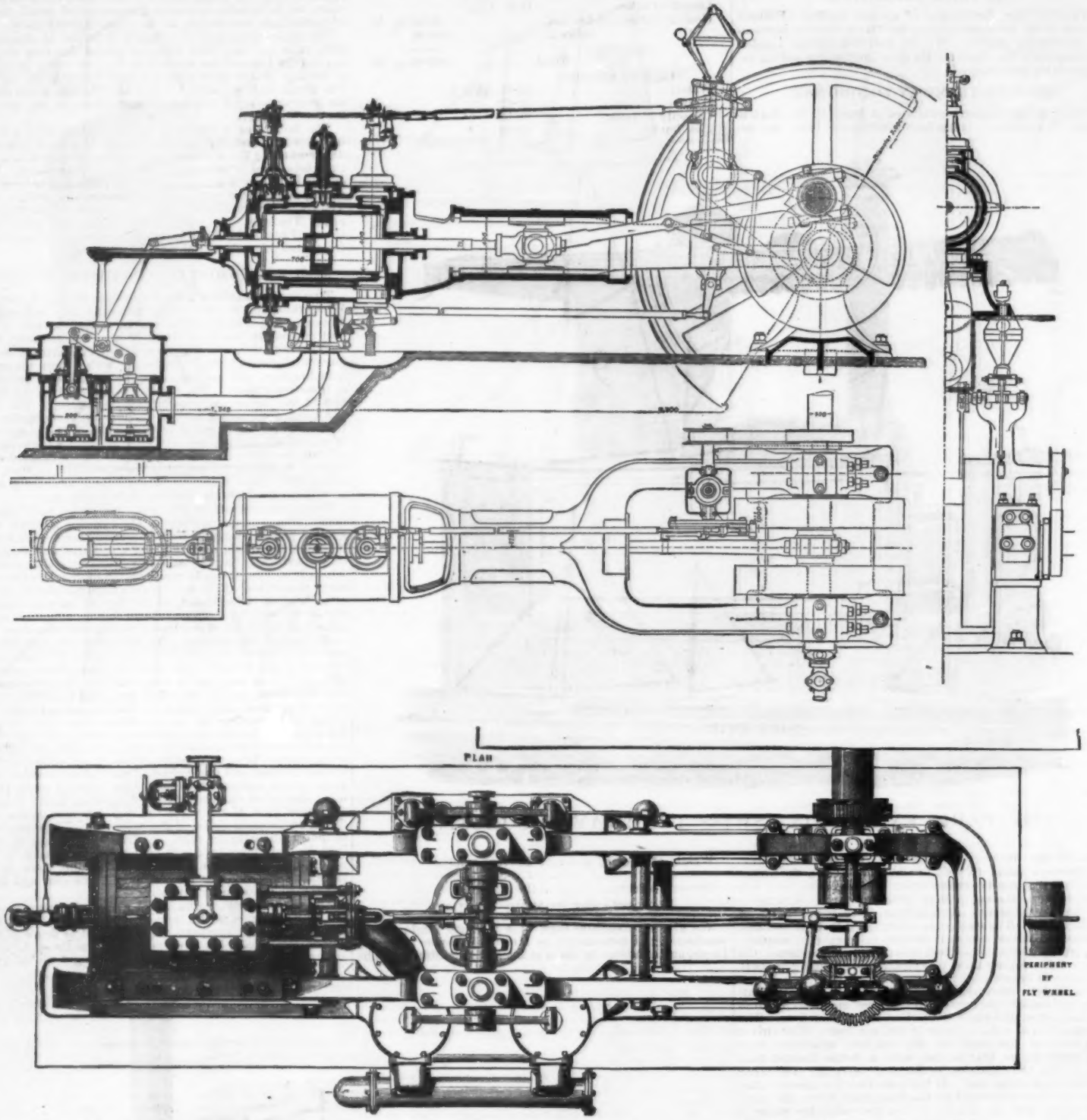
THIS engine was built from the designs of Mr. Brown, of Winterthur, and is well worth inspection for its excellent workmanship, which entitles it to be ranked as one of the best engines in the Paris Exhibition. The framing is a modification of the Corliss frame, with cylindrically bored cross-head guides bolted to pedestals, which form the crank axle bearings, and are connected by a transverse bed-plate to insure steadiness. The cylinder is attached to the other end of the frame, and supported by a pedestal. The feed and exhaust pipes are carried underneath the cylinder, so that the latter can be got at from all sides. The piston rod is continued through the cylinder cover, and serves, by means of a neat arrangement of guide bar supported on a column, to relieve the weight of the piston and to work the air pumps. The connection between these and the guides, as will be seen from the drawing, is very simple.

The crank consists of two cast iron disks with pressed crank pin and counterweights. The cylinder is fitted with a steam jacket, through which the steam must pass before it reaches the valves. The stop valve is placed in the middle of the cylinder's length, and is worked by a lever handle, which it is claimed can be manipulated more easily than the usual hand wheel. The two steam valves are placed one at either end of the cylinder, on the top, in the same straight line as the stop valve. The exhaust valves, which act at the same time to get rid of condensed water, are placed on the under side of the cylinder. All the valves are equilibrated and double-seated, with dead level surfaces. The valve gear is original and effective: the motion is taken from a point in the connecting rod, and is controlled by the governor, so that the steam can be cut off at any point from 5 per cent. up to 70 per cent. of the stroke. The contact apparatus for lifting and lowering the valves differs from the ordinary valve gear in regulating the action of closing the valves independently of springs and air dash pots, and the surfaces being directly brought together, there is no sliding motion and no friction, and the contact disks being provided with India-rubber washers, the action of the valves is nearly noiseless. Instead of the usual dash pot, a steam buffer is used, the upper part of the valve forming a hollow piston, and fitting on the solid piston of the valve seat. The connection of the spindle with the valve is effected by means of rings held in their place by a split nut; this arrangement is very solid, and prevents the spindle from getting loose, at the same time allowing the valve to turn on its seat and keeping the surfaces uniformly worn.

The valve spindle works in a long spindle case, so that the stuffing-box is so far removed from the cylinder that it is always kept comparatively cool, and as drops of condensed steam only, but never steam, escape, the stuffing-box seldom requires tightening up, and the danger of fixing the-



THE PARIS EXHIBITION.—NEW WINDING ENGINE.



THE PARIS EXHIBITION.—HORIZONTAL CONDENSING ENGINE.—THE SOCIÉTÉ SUISSE, WINTERTHUR, ENGINEERS.

spindle or of quickly wearing it away in the usual neck-shaped attenuation in the length of the stuffing-box is avoided.

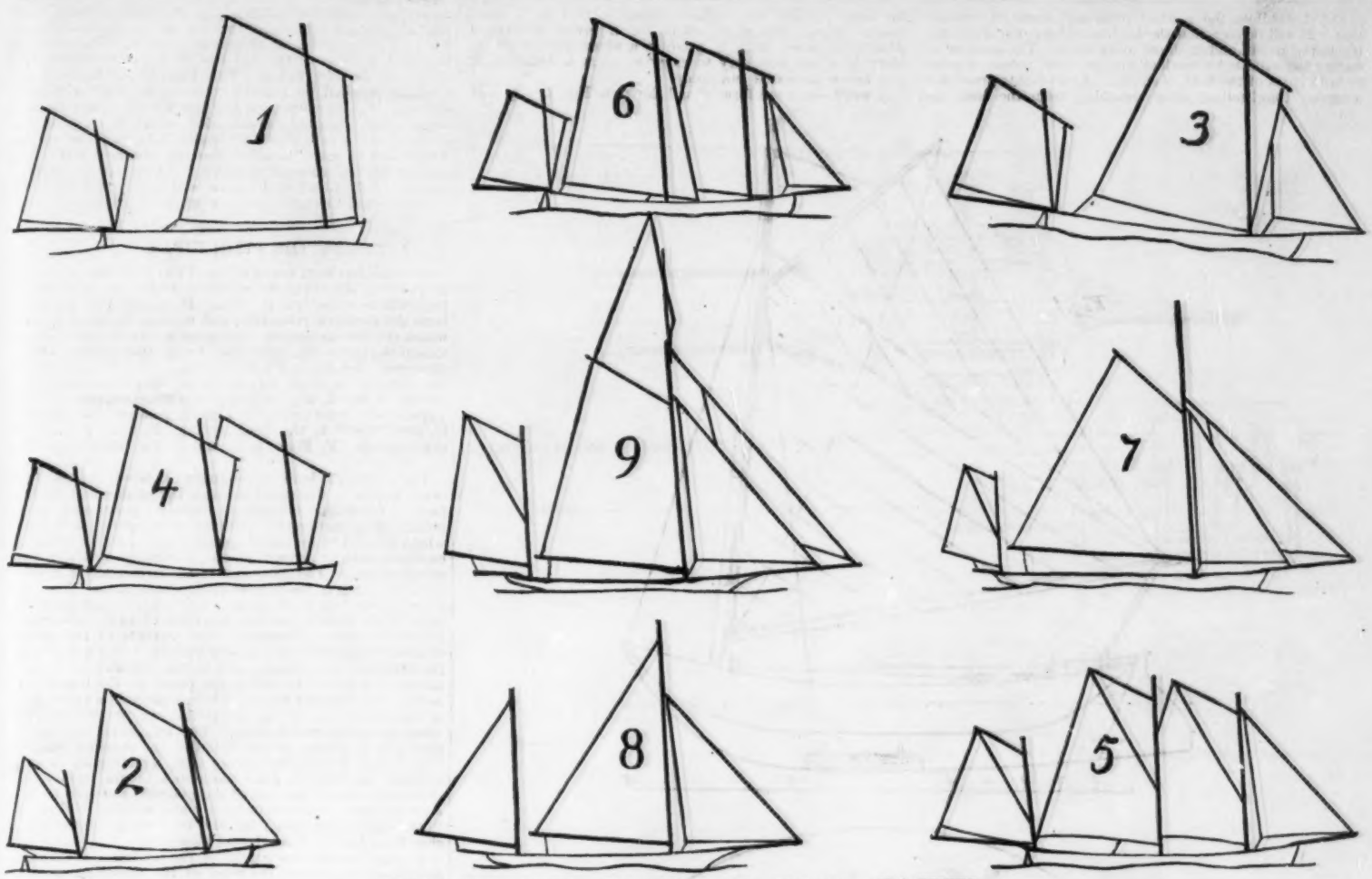
The exhaust valves are worked from an eccentric and lifted by means of radial cams, which impart a quick but silent motion. The engine, nominally 100-horse power, is capable of working up to 160-horse power, makes 100 revolutions per minute, and works so silently and steadily that there is no doubt that the speed might easily be increased. The leading dimensions will be seen from the drawing.—*Engineer.*

A MILITARY RAILWAY.

A PAPER was lately read before the United Service Institution by Mr. J. L. Haddan, C.E., on "Pioneer and Military Railways." A section of a military post and rail or pioneer railway was built on the ground lying waste at the rear of Whitehall-place, to show the simplicity of the work, its constructors being ten soldiers from the Grenadier Guards and two laborers. The railway was primarily designed by the author of the paper to meet the need in the East of a speedily constructed, cheap and effective means of transport for men and stores over a wild country without the necessity of surveying, leveling, and passing through the preliminary stages of ordinary railway making. The section built on Monday in the grounds of Whitehall is a "one central rail" structure with two light side guide rails, the line running upon 7 ft. posts, 440 to the mile, the rolling stock upon it being designed upon the "camel saddle" principle. The carriages and engines fall on each side like panniers on an animal's back, the wheels of the engines, trucks, and carriages being horizontal and gripping the guide rails. The material of the railway is wholly of timbers brought on the ground ready cut for use, and the plans having been explained to the sergeants of the fatigue party, the piles were sunk in the ground, the cross timbers fixed and bolted, and by a series of wedges an 80 ft. or 100 ft. section of the line, running over very uneven ground, is made secure, the wedges taking up any slack in the struts. In the discussion which followed the reading of the paper, Sir Garnet Wolseley, speaking of the railway in the Crimea, said that "though that was not a great success, it was very useful, and by making it the English nation was the first to use railways in war. The great thing in regard to railways used in war was that they should be quickly made and worked, for time was everything. If we had to go to war and to operate inland in a country where there were no roads, it would be of the greatest importance to have a line from the base of the scene of operations, and Mr. Haddan's proposals gave a system which would meet the requirements of an army in that position. As to particular railways which had been proposed for army transports, in these days of short and sharp campaigns, earthworks were out of the question, for now armies did not sit down to long campaigns like the sieges of Troy and Sebastopol. Other systems required good roads, but for a country without the roads, and in rapidity and simplicity of construction, Mr. Haddan's railway would meet an army's wants."

A TRADE MARK CASE.

IN a London trade mark case, the Master of the Rolls has just given a decision, which will be of general interest, not only to traders, but to manufacturers and merchants in every English district. A firm claimed to be registered in respect of an old trade mark, which had been used in their business for a quarter of a century—namely, a dog with a pot, the dog being represented as turning the pot over and licking out of it. The applicants (Jones) claimed that they had a shop in the Blackfriars-road, where they had a sign with that mark. That sign had been hanging there since the reign of Henry VIII. They sought to register that trade mark in several classes. The application was opposed by a firm who carry on business in Sheffield under the name of "J. & Riley Carr," who used a Sheffield mark of a pointer, with the word "staunch" written underneath. It was urged for this firm that the mark of a dog and porridge pot had never been used in respect to edge tools, and that as these things were stamped in outline upon the blades of saws and general metal work, unless the die fell with perfect evenness, the impression was not always very distinct. The difficulty of distinguishing between marks which had any close resemblance was, therefore, increased. As regarded general metal work, the mark had been used for twenty-five years, and the Master decided that the applicants were entitled to have their mark registered. In the class of edge tools, etc., he admitted the objection, on the ground that the applicants had not previously used the mark for such goods, and that it was not distinctive enough. Articles were handed to his lordship to show him that if the head of the dog was indistinctly marked, it would be very difficult to tell between the two marks. In the specialty of files, it was urged that the objectors' files were called "dog files" in the American market. The Master was informed that the dog and porridge-pot was the sign of the applicants' shop; they had used it on their bill-heads and invoices, and now wanted to register it for use on all their goods. His lordship admitted registration in the classes of goods where they had been accustomed to use the mark, but refused it on those where they had not used it, as it was not distinctive enough to distinguish between it and the mark of the objectors. Counsel suggested that it was hard that the applicants having used this mark for a great number of years for their goods should now be compelled to use two distinct trade marks. The Master's reply was decisive: "You are going to sell goods which you never sold before, and you must not take a mark similar to that used by others for that very class of goods." His lordship further instanced a case in which a man had used a hand as a mark for whisky. So far there was no objection. But the man then wanted to sell beer, and desired to use the same mark for his beer, but Messrs. Ailsopp stepped in and stopped him by saying, "That is our mark." The decision is a most valuable one, and in the main cannot be seriously objected to. There is common sense and justice in it, though it looks at first sight rather hard on the firm who regarded a mark on their invoices as equivalent to a right of property in that mark for all their goods.



RIGS FOR OPEN BOATS AND SMALL YACHTS.

BOATS' RIGS.

THE accompanying diagrams are illustrative of various types of rig for open boats and small cruising yachts, each form shown being in actual use. Figs. 1 to 6, inclusive, are specimen rigs for ships' boats, as used in the British navy and merchant marine, and some of which are to be seen on boats belonging to the war vessels of this country. Figs. 7, 8 and 9 are variations of the yawl rig for decked yachts intended for rough water service.

The forms we have selected for illustration, it will be noticed, are in each case examples of that system in which a small mizzen sail is spread at considerable distance from the center of effort, making up (as far as regards balance of sail) for its diminutive size by the increased leverage thus obtained. This system has its best exponent in the English yawl, which is the most handy 5 or 10 ton craft in heavy weather that has yet been invented, and which is steadily gaining in popularity. The advantages gained by the adoption of this principle are convenience in handling, the avoidance of reefing, or at least removing the absolute necessity for that awkward task, ease of trimming sail and consequently greater command of helm, and (what is perhaps still more important for rough work) the fact that a ready means of lying to, head to wind, is provided in case of an emergency. The disadvantages are the difficulty of spreading enough sail for speed in light weather, the inconvenience of having a "bowsprit over the stern" (as the boomkin or outrigger is sometimes described), and the necessity of a steering yoke, bent tiller or some such makeshift in case the mizzen mast is stepped forward of the rudder head. The cat rig of American waters is so incontestably superior for use in smooth and sheltered bays and creeks that there is no probability of its being superseded in its own peculiar domain; but in outside service the single sail of the cat boat does not compare favorably with an arrangement in which the sail area is subdivided into small and handy pieces. The cat boat is, as a rule, faster on a wind than any other class of small sailing vessels, but is not so safe nor so easy to steer as ships' boats, rigged as shown in the diagrams.

Fig. 1 is a fore and mizzen lug, and is a common rig, though perhaps not so commendable as some of the others. It is extremely simple. Only one halliard is needed for each yard. The mizzen sheet is led through a sheave or ring at the end of the outrigger, which latter may be unshipped when not in use.

Fig. 2 shows a boat rigged with jib, sprit fore, and sprit mizzen. The outrigger is omitted, the mizzen sail being provided with a boom instead, and the mizzen mast being stepped so far inboard as to allow for sheet attachment, etc. With this rig sail may be readily shortened by unshipping the main sprit, or, if necessary, dropping the mainsail altogether, the balance of sail being preserved in either case by the jib and mizzen. Similarly the foresail, with or without sprit, may be hoisted alone, and if the boat is in proper trim she should mind her helm well.

Fig. 3 differs from Fig. 2 only in the substitution of lug for sprit sails, stepping the mizzen mast further aft, and having a detachable outrigger. As in Fig. 2, the balance of sail is kept when using foresail alone or jib and mizzen.

In Fig. 4 we have an example of the manner in which three masts can be used in an open boat of, say, 25 to 35 feet long. The sails are fore, main and mizzen lugs. The main being dropped, the rig is the counterpart of that shown in Fig. 1, with somewhat reduced canvas.

Fig. 5 is a three-masted boat, having fore, main, and mizzen sprit sails, carried further aft than in Fig. 4, a jib being added to preserve the balance. A boat so rigged can be handled under jib and mizzen alone, or in scudding under foresail alone, with the sprit out if necessary. This is a very pretty rig, and admits of spreading a large amount of sail, which can easily be shortened; but requires quite a crew, if the principle of "a man to every sheet" is observed.

Fig. 6 is the same arrangement, with the substitution of lug sails for the sprit sails of Fig. 5.

All these rigs, Figs. 1 to 6 inclusive, are applicable to open boats, the simpler forms (such as Figs. 1, 2 and 3) being adapted to even craft as small as the 15-foot Whitehall boat, while the three-masted rigs are more suitable to the ship's launch and may be used with boats as long as 40 feet. Canoes are often fitted with suits of sails analogous to those shown in the first three diagrams, modified of course to meet the peculiar requirements and conditions of canoeing.

With the three lower diagrams of our illustration we pass from open boats to the small decked yacht, the object being to show how the same principle of division of sail may be introduced on the latter. For yachts of from 25 to 35 feet keel, and intended to cruise in rough water, safety and comfort being preferred to speed, the rigs shown in Figs. 7 and 8 are excellent ones.

In Fig. 7 the mizzen sail, driver, dandy, or jigger, as it is indiscriminately called, is reduced to a size which looks absurdly small, but which has some advantages. With the proportions shown, the mizzen sail seems a mere handkerchief, and, by withdrawing the sprit, dwindles down even more, but is still quite enough to keep the yacht head to wind, and when sailing to balance the jib by proper trimming. Many of the English yachts of considerable tonnage are similarly rigged, in some cases the arrangement being such that by unshipping the driver mast and fitting a spare boom the vessel becomes a cutter, and may carry a racing suit of that rig when desired. There is no question that for speed the cutter (or sloop) is superior, as a rule, to the yawl, a large part of the canvas of the latter being devoted to steering rather than to impelling; but on the long cruise the yawl in turn has the advantage. Hence it is not an uncommon thing for some of the English yachts to undergo a regular annual metamorphosis. With the proportions illustrated in Fig. 7 it is advisable to have at least one row of reef points in the larger sail.

In Fig. 8 this is done away with altogether Here we have a specimen of the most comfortable cruising rig imaginable. No reefing is required, and only three halliards to take care of. With the jib and driver she can jog along comfortably in any ordinarily stiff blow, will steer herself while her crew of one makes his fire and prepares his meals below, and may always be counted on for steady behavior. This is a yawl rigged with Bermudan triangular sails, so proportioned that the jib and mizzen balance each other and are large enough to carry the boat along at a moderate speed, but not so large as to require reefing in any wind that a yacht would be apt to meet.

Fig. 9 shows how the same boat may be fitted with a racing suit. It is possible also to add a square stay-sail between the masts, when on a long stretch with the wind free, though generally a stay-sail would be more trouble than it is worth.

Fincham's tables, which are republished in Alston's "Seamanship," and in "Shipbuilding, Theoretical and Practical," by Naval Constructor Wilson, U. S. N., give minute details of the dimensions of spars for the types of boats shown in Figs. 1 to 6. The diagrams are, however, for all practical purposes, sufficiently intelligible to enable the reader to reduce the proportions to figures in applying them. The details of halliards, sheets, stays, etc., are too familiar to require minute description here.

A SMALL BOAT FOR ROUGH WATER.

THE controversy respecting the comparative merits of the different types of canoes hinges to a great extent upon the relative conduct of these craft in rough water. It is evident that the ability to stand ordinarily heavy weather is one of the most important, if not the very first, essentials of the cruising canoe, and a number of models have been proposed, having this point especially in view, of which that known as the "Nautilus" type, an English plan, is perhaps the most successful. But in striving to produce an effective canoe for rough work other important points, such as lightness, absence of ballast, low freeboard to permit easy paddling against a head wind, and, in short, speed and handiness in smooth water have to suffer in order to obtain the best behavior in rough water. It seems impossible, so far as present knowledge extends, to combine functions so opposite without sacrificing utility in one or the other directions; and at best the cruising canoe can only be considered as a compromise in which a high average is maintained, without special adaptability to particular conditions.

In the plans for a rough water boat, herewith illustrated, attention has been concentrated upon the single purpose of producing a small craft capable of withstanding almost unlimited knocking about; and it is not claimed either that she will be fast or even equal to the ordinary cat boat in smooth and shallow water, but simply that she will be safe, comfortable, and as efficient as possible for her work.

A first glance may convey the impression that the model shown is an exaggeration or even grotesque; but a little consideration will lead to a contrary opinion. It is at all events tolerably evident that such a craft will look decidedly better in the water than in the building shop. The principle here embodied is one which is familiar to all who have built or sailed miniature yachts, in which its adoption gives the very best results. It is, briefly, combining extreme beam, hold on the water, and the greatest practicable depth of ballast, with the smallest possible cross section, thus obtaining the advantages of extending the dimensions of depth and breadth without the accompanying (in ordinary vessels) disadvantage of having a corresponding bulk to drag through the water. This is done by retaining in part the shape of the cat boat, but extending the keel downward, instead of a centerboard, and carrying the ballast at the lowest point of the keel, in place of arranging it on the floor of the hull. This may easily be effected in the case of a miniature yacht, but becomes a critical expedient when applied to large vessels. Still we have seen ordinary sloop yachts, not constructed with a view to such a disposition, in which iron ballast, to the amount of a ton or more, had been added below the keel with good results. The plan is certainly practicable for boats of the dimensions of the one illustrated, as it is not difficult to give the necessary strength, and the jerking movement which is condemned in a larger vessel is not an obstacle.

The principal dimensions of the boat illustrated are as follows: Length between perpendiculars, 15 ft.; extreme beam over all, 6 ft.; depth of hull at midship section, measured from upper surface of deck to bottom of garboard streak, 1 ft. 6 ins.; deck sheer at bow, 1 ft. 3 ins.; at stern, 6 ins.; depth of keel below hull, 1 ft.; draught, about 2 ft.; mast, from deck to hounds, 12 ft.; to truck, 16 ft.; full length from step to truck, 17 ft. 3 ins.; diameter, 3½ ins., tapering to 2 ins.; boom, 13 ft. long; diameter, 3 ins., tapering to 1¾ in.; gaff, 7 ft. long, including jaws; diameter, 2½ ins., tapering to 1¼ in.; sail, 10 ft. hoist, 12 ft. on boom, 6 ft. on gaff; leach, 13 ft. 6 ins; rudder, 2 ft. 6 ins., full length; hatch, 4 ft. long, 2 ft. 6 ins. wide; combing, 6 ins. high, above deck; upper slide, 4 ft. long.

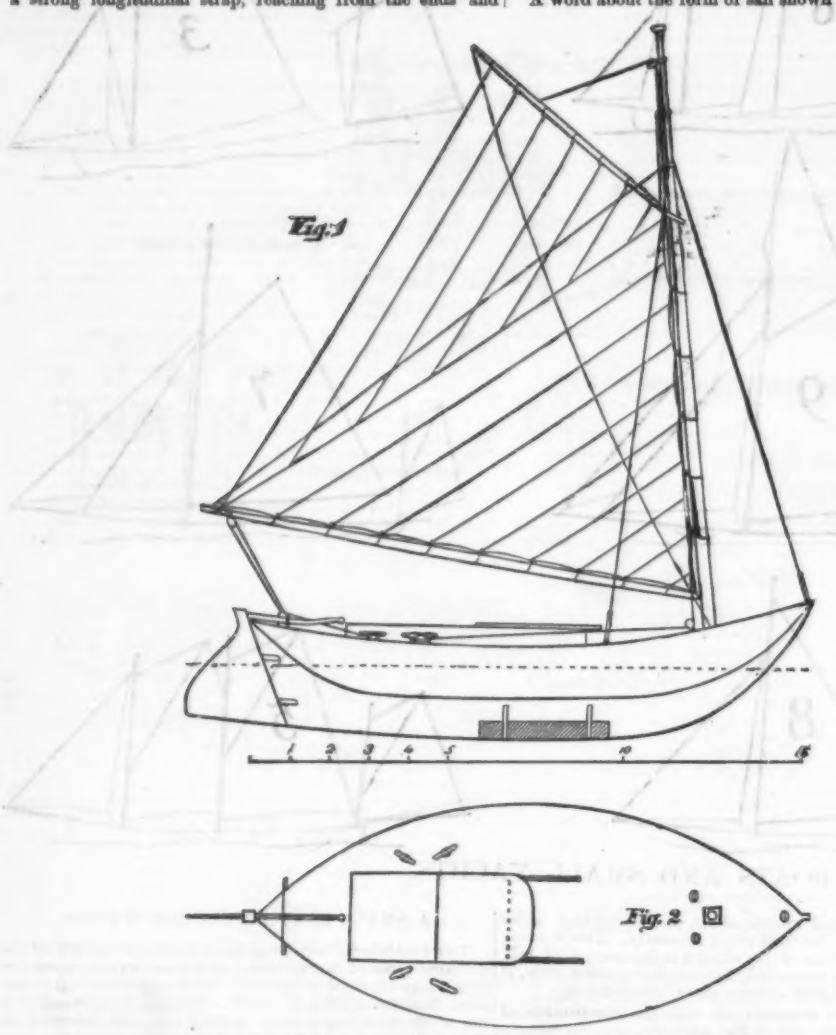
Fig. 1 exhibits the general form and mode of construction. It will be seen that the hull has a long, flat floor, gently rising reach, and a slight after sheer. The mode of securing the ballast, by vertical wrought iron straps attached to both sides of the keel, is shown. As a further precaution a strong longitudinal strap, reaching from the ends and passing under the bottom of the keel, binding the ballast to it, might be added. The ballast itself is of cast iron, galvanized, made the thickness of the keel (2 ins.) and of length and depth in accordance with the preference of the builder, a size sufficient to give about 200 lbs. weight (in air) being probably about the best for general purposes. The dimensions of the bar for any given weight may be readily calculated, by allowing 480 lbs. as the weight of a cubic foot. Lead ballast might be substituted. It has the advantage of greater density and could more readily be cast, but it is much more expensive than iron and not so easy to work into the keel.

A deck plan, showing the arrangement of the sliding hatch, and of the cleats, traveling wire, etc., is shown in Fig. 2.

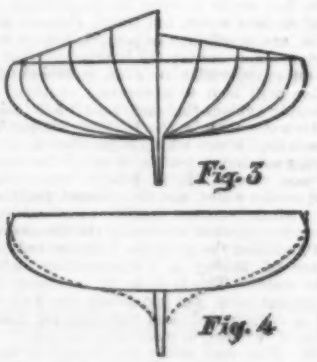
Fig. 3 is a cross section, the right hand half representing the bow, and the left the stern. From this the extreme flatness of the floor and breadth of shoulder can be seen.

In Fig. 4 a comparison between the plan above described and that of what is known as the English "lead mine" type is presented, the section being a midship one. In large vessels, where it is difficult or impossible to obtain the strength necessary to carry ballast outside of the keel, a compromise is sometimes adopted, giving a section not very unlike Jackson's famous lines, which have been previously commented upon at length in these columns. It will be noticed that although the dotted outline gives a much prettier form—if, indeed, the appearance of a submerged cross section is worth taking into account—yet the advantages are more than balanced by the uglier but simpler and more effective outline contrasted with it. Given a certain area of cross section to drag through the water, it makes little difference how it is distributed, provided the entry and run are in keeping. What is taken off the depth of hull, in the diagram, to produce the dotted outline, is added in the shape of increased shoulder (or greater stability) in the other; while the ballast, being carried at a much greater depth, has more effect for a given weight; or, what is the same thing, to produce a given amount of stability it is not necessary to carry so great a dead weight, and hence increased buoyancy.

A word about the form of sail shown in Fig. 1. By making the inner portion of the Bermudian or triangular shape, running the cloths in the proper direction for such a sail, and adding a strong bolt rope, a serviceable storm sail is produced by simply letting go the peak halliard and hauling in snug the peak by means of the downhaul shown. Thus no reefing is required—a great gain in a boat of such small size, in which it is intended that the occupant should be as fixed in his position as though in a canoe. The cloths in the peak portion of the sail run in the usual direction, as shown in the illustration. This form of sail has been successfully applied on many large sea-going craft with great success. The idea has been familiar for years, but does not seem to have received the attention which it really merits. It furnishes a sail which is readily adaptable to varying winds, and is much handier than an ordinary reefed sail, and avoids the ruinous stretching which always affects a common gaff sail when the peak is dropped and the whole strain allowed to come upon an unprotected bias.



A SMALL BOAT FOR ROUGH WATER.



THE PIERI RIFLE.

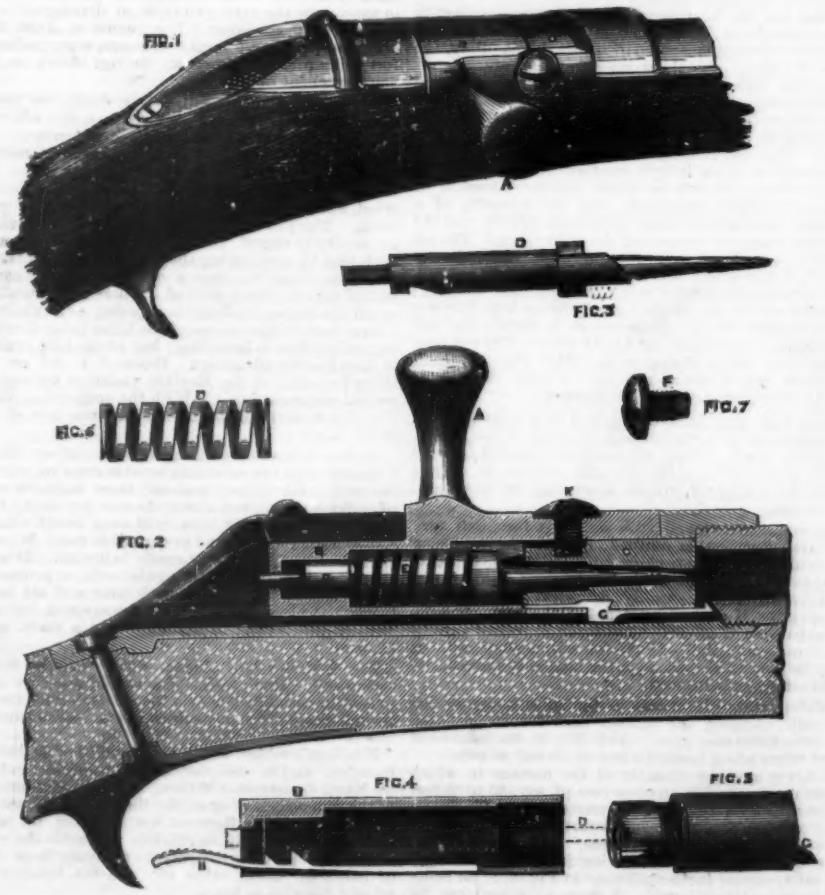
So much has been heard of the Pieri rifle that a description of it by the aid of the woodcut which we give on this page will be of general interest. It differs very materially from the British service rifle, and belongs to those types in which the breech-loading apparatus works in a line with the axis of the piece—the principle being that of the Dreyse, Chassepot, Berdan and Vetterli guns. The breech mechanism consists in all of only seven pieces—the cylinder, with handle, A and B, Figs. 1 and 2; the trigger-spring, H, Figs. 1 and 4; the head-piece, C, Figs. 1, 2 and 5; the extractor, G, Figs. 2 and 5; the spiral spring, E, Figs. 2 and 6; the thumb-screw, F, Figs. 1, 2 and 7; the striker, D, Figs. 2, 3, 4.

The cylinder is bored throughout its whole length, to receive within it the spiral spring, the striker and the head-piece. The striker is larger in diameter at one end than the other. Between the two portions is a raised part, against which the end of the spiral spring bears, and this raised part carries a tooth or projection, the extremity of which has a spiral surface. The other end of the striker has a notch in it for the tooth of the trigger-spring to work in. The head-piece is bored throughout, in order to give a passage for the point of the striker, and has the form of two connected cylinders of different diameters. The surface of the cylinder of greater diameter has a groove parallel to the axis in which the extractor, G, is placed, and in the cylinder of lesser diameter is a groove in which the point of the thumb-screw works. On the rear face of this last piece is a small notch, in which the point of the projection on the striker lodges when the arm is at full cock. The trigger-spring, which is placed in a groove in the cylinder, is provided with two teeth, one to prevent the spring from withdrawing from the cylinder, the other to take the notch in the striker. The spring projects to the rear of the cylinder and terminates in a thumb-piece, which is pressed when wishing to fire. The thumb-piece is protected by the two wings of the breech-shoe from injury or accidental blows.

To load the rifle, the handle of the cylinder is turned up and drawn back until the head of the thumb-screw lodges against the head formed on the breech-shoe. The rotation of the cylinder is not given to the head-piece, which is prevented from rotating by the projection on the extractor, which works in a groove cut along the bottom of the breech-shoe. By virtue of this the projection on the striker is compelled to rotate with the cylinder over the spiral surface of the cavity in the head-piece, and consequently to go back in the cylinder until the projection in the trigger-spring enters the notch in the striker, when the spring is compressed.

The cartridge having been placed in the chamber, the cylinder is forced forward and turned to the right, by which movement the projection on the striker is brought opposite the cavity in the head-piece, and the arm is ready to be discharged.

In order to place the arm in the safety position, or half-cock, after loading, it is only necessary, while closing the breech, to press on the trigger at the same time with the thumb. By this the projection on the striker glides down



THE PIERI BREECH-LOADING RIFLE.

the spiral surface of the cavity on the head-piece, and the spiral spring is released without any blow being struck on the cap. On drawing back the cylinder after firing, the empty case is removed.

Respecting the working of the gun and its efficiency, we may refer to a report by the commandant of the Naval School of Gunnery at Bunitini to the commander-in-chief of the First Maritime Department at Spezia:—In the course of more than five months these arms were used under all the conditions of the maritime service with full success. The operation of loading can be reduced to only three movements of the greatest simplicity. The various parts relating to the gas-check and trigger present great solidity, and remove all fear, provided they are made of suitable material, that any injury could happen to them, even under the severest trials which could be given to a small arm. By placing the trigger on top of the stock the advantage of being able to handle the arm with great ease without producing the slightest deviation at the moment of firing is secured. With regard to the operation of placing the arm in the safety position it was thought at first that some difficulty would be found when it was performed by recruits, or men not sufficiently practiced in the use of the weapon; and in order thoroughly to determine this important point, on several occasions a group of ten men was taken, and the movement being once only explained to them, it was found that in 200 trials only 3 per cent. fired the charge prematurely. In no less than 385 discharges with one of the guns, and in 200 with the other, in which the spiral surface was injured, there was no occasion to affirm any, even the slightest, inconvenience arising from the gas-check or from the trigger. The movement necessary to place the handle of the cylinder in position to withdraw the head-piece was always accomplished with ease. In the firing there was not the slightest escape of gas from the breech-closing apparatus, the expanding cartridge being used. It was found that from twelve to fourteen rounds could be fired in a minute, carrying the arm to the "present" each round, and this may be said to be the maximum which can be practically reached with small arms, inasmuch as it has been shown that after about thirty shots at that rate not only did the barrels become so hot that it was impossible to handle the rifles, but also the shooting of the rifles was seriously affected. The operations of dismounting and remounting the action are very simple, and can be carried out with extraordinary ease, and every part of the mechanism cleaned in a very short time. The trial directed to this point showed that a person well acquainted with the arm could dismount and remount the action three times in a little over a minute. It is hardly possible that any part of the mechanism could be injured, the pieces most liable to injury being of such simplicity that they could be repaired with the means available on board ship, and their number is so small that the supply of spare pieces of those most liable to injury, such as the extractor, striker and spiral spring, would be an easy matter. The stock of the gun being without any holes, the strength of the arm is unusual, and it can be manufactured very quickly—a fact of much importance.—*Engineer.*

NEW ARRANGEMENT FOR TELEPHONE.

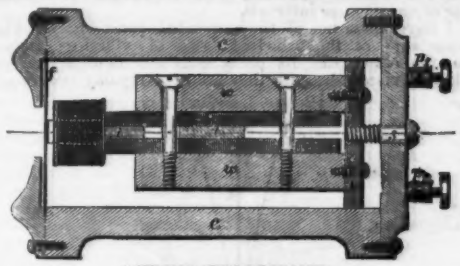
By BROWN AYRES.

THE writer has experimented a great deal with the different forms of telephone, but more from a scientific than a practical point of view. Still in the course of his experiments some facts have been reached that are worthy of notice. He has devised a form of instrument differing in construction from the ordinary Bell telephone, and having the advantage of greater ease and cheapness of manufacture. This instrument has been used by many scientific men who have visited the Stevens Institute, with the nearly unanimous opinion that it compared very favorably with the best yet constructed.

A sectional view of this instrument is shown in the figure. The wooden case, *c*, 4¼ inches in length by 2¾ in diameter, is, in the instrument made by the writer, of mahogany. Through this cylindrical block is bored a hole, 2 inches in diameter. Into this is fitted snugly the arrangement of magnets and coils tight enough to prevent its rattling about, but not so tight as to prevent its adjustment by means of the screw *s*. Two horseshoe magnets are used; they are 3 inches long and can be bought at any toy store at a cost of about fifteen cents apiece. A compound magnet is formed by superposing them, like pole over like, having a piece of wood, *i*, ⅛ inch in thickness, between them. A small piece of round iron or iron wire *i*, 1/16 inch in diameter and 1¼ inches in length, is filed flat on two opposite sides to within about ⅝ inch of the end—somewhat over half. One of the pieces is placed between the superposed like poles, and the whole is held tightly together by means of two screws passing through and into two pieces of wood *w*, *w*. On the ends of *w* is screwed a strip of brass, *b*, which, by means of a screw thread in its center, allows the whole arrangement to be moved in and out by the screw, *s*. On the pieces of round iron *i*, are slipped bobbins (which I have made of postal card, boxwood, or hard rubber), whose dimensions are: length ⅞ inch, diameter ½ inch, and core just large enough to fit snugly on *i*. They are wound with No. 38 wire, or for short lines coarser wire can be used. Connections are made in the ordinary way to binding posts p_1, p_2, and a disk of thin ferrotype, *f*, is placed over the end, and the magnets brought as near as possible without touching when the plate vibrates. The mouthpiece is like that of any ordinary telephone. One great advantage of this form is the case with which a strong magnet can be made, and strength of magnet is an essential in the telephone. My instruments have a resistance of about 80 ohms, and I have worked them very satisfactorily on actual wires up to 75 miles and with resistances much higher. There is considerable choice in the ferrotype plates one meets with; the best that I have found is an imported article, of a maroon color, and very thinly coated with varnish. The ordinary black American plates do very well, but the varnish is rather thick and they are not as satisfactory as the French. Of course the dimensions can be varied at pleasure, but the plate should not depart far from the size given, for if so, the fundamental tone of the plate will interfere with distinctness of articulation.

While experimenting on a wire of the Virginia Telegraph Co., the writer had occasion to notice more particularly a very curious fact which from previous experiments he had suspected before, that is, that the telephone seems to work more satisfactorily on a leaky line than on one perfectly insulated. His experiments were made on four wires. No. 1 was a wire of the Western Union Telegraph Co., from Staunton to Charlottesville, Va., a distance of 40 miles. No. 2, a wire of the same company, from Staunton to Covington, Va., a distance of 70 miles. No. 3, wire of the Virginia Telegraph Co., from Staunton to Harrisonburg, a distance of 25 miles, and No. 4, one of the Baltimore and Ohio R. R., between the same points, 25 miles. On Nos. 1, 2 and 4, which were all excellently well insulated, the earth current was very marked, in some cases almost entirely drowning the sound of the voice, while on No. 3, a miserably insulated line, the earth current was comparatively insignificant, and conversation was carried on with the greatest ease. When this line was so nearly dead grounded that it was nearly impossible to work with the Morse system over it, the telephone worked to a charm. The writer has sought to explain this as follows, which, be it remarked, is only provisional, for the subject deserves more attention than he has been able to give it.

It would be difficult to choose two points, at any considerable distance apart, which would be at so nearly the same potential that when they were connected by an insulated line, no current would pass. If the line were perfectly insulated the electromotive force of the earth current would be proportional to the difference of potential of the points; hence, if this difference were great the current would be great. On the other hand, if the line were leaking, this would allow of the readier equilibration of the potential at the terminus of the line and the leak, and of the difference between any two leaks, so that the earth current arriving at the distant telephone would principally be that due to the difference of potential of the nearest



AYRES' TELEPHONE.

leak to the distant terminus and that terminus. The telephone current, of course, will lose in strength by being divided into so many branches, but being harmonic in its character, the successive currents reinforce the motion of the plate; hence the difference in the incoming current is not so readily perceived, and by adjusting, nearly as loud sounds can be obtained as if the line were insulated.

This observation agrees with the fact observed by others, that two wires could be buried in the ground and yet a telephone circuit made through them. Prof. A. M. Mayer has experimented on a railroad track, using the two rails as conductors, and badly insulated and connected at switches as they were, good results were still reached. The writer has conversed with some ease between different floors of the same building, using the gas and water pipes as conductors. The same facts were observed with Mr. Edison's so-called "Etheric force;" and in fact many observations point to a close analogy between these telephonic currents and the "Etheric force," both being rapidly reversed currents. It should be noted that in the above experiments Nos. 1 and 2 ran northeast and southwest, while Nos. 3 and 4 ran essentially northwest and southeast. No. 4, though well insulated, was much better than 1 or 2. Such experiments give us some idea of the infinitesimal character of the currents active in this instrument, which, though escaping at every point almost, still arrive at a distance of twenty-five or fifty miles with sufficient strength to operate the telephone satisfactorily. One of the telephones used in these experiments, when the plate was pressed in with the finger and held, gave, on a high resistance Thomson galvanometer, a deflection of only 1°. This points to the use of the telephone as a delicate electroscope, especially valuable where reversed currents are to be observed, as in Mr. Edison's "force," and with it very accurate measurement could be made, placing it in the cross of the "Wheatstone Bridge," or winding it differentially and balancing until no "click" was heard in the instrument at closing and breaking circuit. In fact, this is only one of the many uses to which it can be applied other than as a transmitter of speech or music, and from its wide adaptation, its beautiful simplicity, and the marvelous minuteness of the forces involved, it deserves to be classed, as it undoubtedly will be, among the greatest and most interesting inventions. —*Journal Franklin Institute.*

THE MAGNETO ELECTRIC LIGHT.

By CAPTAIN W. DE W. ABNEY, R.E., F.R.S.

AT intervals during the last three years it has been my duty to ascertain the value of the illuminating power of different sources of light, which have been brought before Government for military purposes. As there is nothing secret in the results obtained, it seemed to me that I might communicate them to the Royal Society, and I have obtained permission so to do.

The primary object of the experiments was to ascertain the relation between the horse-power expended, the light produced, and the number of revolutions of the armature. The machine employed was of the Gramme form, and weighed somewhere about 17 cwt. It had three pairs of vertical coils, one of which was used for magnetization. To work it, what is known as the steam sapper was employed. This is a road locomotive from the shops of Aveling & Porter, of Rochester, and is adapted to driving machinery by applying a band to the fly-wheel. It works fairly steadily when not overtaxed. An indicator was attached for taking diagrams from which to calculate the horse-power expended. The number of revolutions of the armature was taken by a velocimeter, and a large tangent galvanometer was inserted in the circuit, the diameter of the arc being 33 times that of the needle. An automatically working electric lamp having perfectly dry square carbons of ¼ inch side was the source of light, and was placed at fixed distances of 75, 150, or 50 feet from the measuring apparatus, as circumstances required. It gave a steady light when the engine worked regularly, and the brilliancy of the light was not increased by altering the distance apart of the carbons. When a series of readings was to be taken, the horse-power expended in driving the machine with the collecting brushes up was found, and then the brushes turned down, and the light allowed to burn for ten minutes before any measurement was taken. The number of revolutions of the armature was then approximately ascertained, and a diagram taken when the velocimeter was applied to the machine. The readings of the galvanometer were recorded by an assistant working under my colleague, Captain Armstrong, R.E., and the measurements of the illuminating power taken by myself and checked by an intelligent assistant.

To secure the separation of the different portions of the spectrum, resort was had to absorbing media. After many trials I came to the conclusion that nothing seemed preferable to red glass, which absorbed practically every part of the spectrum except the red end, and an ammoniacal solution of copper sulphate. These two absorbing media were employed in the experiments; very little of spectrum is left unaccounted for, and the results obtained are sufficiently striking to record.

A red glass was obtained which had sufficiently plane surfaces, and a cell with parallel sides was used for holding the copper solution. The absorbing media were placed between the rod and the opaque screen, and absolutely parallel with the latter. The light transmitted through the red medium was first measured, and then through the blue. If the first and last of the readings compared favorably with each other, the series was taken as worthy of confidence. If, on the other hand, great fluctuations were observed, which was sometimes the case owing to the occasional irregularities of the motive power, and to impurities in the carbons themselves, a fresh set of readings was taken. As often as possible readings were taken through the blue and red media at the same number of revolutions per minute of the armature. This was not always practicable or even necessary. This will explain the reason of the variable revolutions recorded in the tables. I may remark that the revolutions were always taken at the commencement and end of each set of readings, and if these were tolerably close the mean was taken as the correct value for the mean of the readings. With any great variation, say of more than ten revolutions, the readings were rejected altogether. It was found difficult to make a comparison with a standard or pair of standard candles, owing to the small distance from the screen they sometimes occupied; hence an intermediate light from a paraffine lamp was made use of, which before and after each series of readings was compared with the standard candle. The variation of the lamp light was very small, ranging from 10·23 to 10·05. The light from the electric lamp was admitted into the observing-room through an aperture in the wall of about 18 inches square, and great care was taken that any reflected light was cut off the screen.

In addition to the optical readings, an endeavor was made to secure a record of the actinic value of light. Paper sensitized with silver chloride was exposed to the light at a distance of three feet from the carbon points, one strip was placed behind a cell filled with quinine sulphate, while another was exposed to the full action of the unshaded light. The times of exposure varied between one and ten minutes. The intensity of the actinism was measured by Roscoe's method, which need not be described. The curve obtained from the paper exposed behind the quinine cell is practically identical with that obtained optically from the blue components when any one point in the former curve is made to correspond to a point in the latter which has the same abscissa. The following tables give the results of the experiments. The horse-power given is the total horse-power recorded less that required to drive the machine with the brushes up.

Expenditure of H.-P.	
Revolutions.	H.-P.
240	1·0
308	1·6
350	2·5
400	3·8
460	5·6
480	5·7
520	7·9
550	8·5
565	9·0

Integration of Blue Light.	
Revolutions.	Candles.
240	360
308	660
350	750
425	1,700
460	2,500
490	3,000
520	4,860
550	4,800
565	6,500
580	6,000
600	10,100

Integration of Red Light.	
Revolutions.	Candles.
240	180
308	280
460	860
500	1,080
520	1,300
540	1,620
575	1,520
580	2,100
600	2,400

Integration of Actinic Power.	
Revolutions.	Candles.
350	800
460	2,750
560	9,000
580	10,050
600	11,020

Currents. Machine No. I.

Revolutions.	Tangents.	Remarks.
300	1·15	1st set of experiments.
350	1·31	
460	1·80	
540	2·47	
200	·51	Experiments during which the illuminating power was measured.
308	·90	
370	1·33	
425	1·48	
460	1·66	
500	1·96	
580	2·20	
600	2·30	

The following is a statement, furnished me by Captain R. Y. Armstrong, R.E., of the electrical conditions of the circuit:

The resistance of the stationary wire — 4·46 ohms.
" " " magnetizing coil — 0·44 ohm.

In the generator the resistance of the light circuit coil — 0·24 ohm.

The light coils were in divided circuit, as were also the right and left stationary coils.

When driven at from 375 to 383 revolutions, the resistance of the voltaic arc was about 0·18 ohm; the other resistances in the circuit were 0·7 ohm. The electro-motive force of the machine when driven at the above speed was 111 volts, a measure which has been arrived at by Captain Armstrong from other experiments. The electro-motive force between 375 and 383 revolutions of the armature was assumed to vary as the number of revolutions, an assumption which was borne out as practically correct by other measurements made for the purpose. In order to ascertain what effect the insertion of resistance had on the current, the following experiment was undertaken by Captain Armstrong with a smaller form of Gramme machine, called Machine No. II. Two resistances were inserted in the circuit for two different sets of readings, in the first case 1·1 ohm of total resistance, in the other 2·72.

The following table refers to these experiments:

Revolutions.	Currents. Tangents.	Machine No. II. Remarks.
398	1·40	1st set of experiments.
490	1·88	
846	3·08	
264	·10	
280	·12	
288	·17	
384	·38	
438	·48	
458	·53	2d set of experiments.
484	·56	
534	·67	
692	·92	
842	1·25	
863	1·33	
1,014	1·45	

It will be noticed that practically the electro-motive force increases directly as the number of revolutions of the armature, a result which might have been expected theoretically. It will also be seen that the current for any given number of revolutions varies inversely as the resistance in circuit, or, in other words, that the electro-motive force for a given number of revolutions is constant.

In any results, therefore, which are given descriptive of the light produced by any machine, the following should be noted:

Number of revolutions of armature;
Resistance in circuit;
Horse-power expended;
Color of light measured;
Electro-motive forces,

together with the size of the carbons employed, and other obvious details.—*Proceedings of the Royal Society.*

ELECTRO-HARMONIC TELEGRAPHY.*

By F. L. POPE.

I.

LET us, in imagination, transport ourselves backward over a period of three centuries. It is a summer evening in the ancient Italian city of Pisa—a city whose curious leaning tower and imposing cathedral have been reckoned for centuries among the architectural wonders of the world. Beneath the lofty ceiling of the great cathedral a magnificent central chandelier, suspended by a slender silver chain, swings slowly to and fro in the gentle southern breeze that steals through the open arches. From his station in the chancel, idly at first, then eagerly and intently, a grave-faced choir-boy follows with his eyes the cluster of glittering lamps, as ever and anon a sudden current of air sets it swinging in a wide arc, and then, ceasing for a time, allows the motion to die away in gradually lessening oscillations.

What could there have been in this simple occurrence which so interested the youthful observer in the chancel? It was this: He had noticed, what doubtless many others had noticed before, but without in the least apprehending its significance, the fact that the oscillations of the suspended chandelier, whether great or small, were always, without exception, performed in *equal times*. Our choir-boy, although a mere youth, had nevertheless already become something of a philosopher, and his subsequent reflections upon the remarkable fact which had thus incidentally attracted his attention led him directly to the discovery of one of the most comprehensive and far-reaching of all physical laws—the law of *isochronous vibration* (the word isochronous being derived from the Greek, and meaning "in equal times"). This discovery was but the first of a long and brilliant series which have justly rendered the name of Galileo forever immortal in the annals of science and of history.

In order that we may arrive at a clear understanding of the principles underlying the different varieties of the telephonic, or, in more general terms, the electro-harmonic system of telegraphy, and that we may be able to trace intelligently its origin and development, it is essential that we should first become somewhat acquainted with the laws and leading phenomena of vibratory or undulatory motion in general. Having done this, we shall find no difficulty in passing to the consideration of the special practical applications of these laws which have recently been made in the domains of electro-telegraphy and electro-acoustics, and which have been attended with such remarkably brilliant and successful results.

Let us consider for a moment some of the peculiar properties of a body freely suspended from a fixed point—in other words, a pendulum. I suppose there are not many here present who do not treasure among the happiest memories of childhood the associations connected with the swing. It was simply a seat suspended by two ropes, perhaps from the horizontal branch of some overshadowing tree. I shall probably be safe in assuming that you all have a tolerably vivid recollection of most of the phenomena presented by this mechanical contrivance when in active operation; a very fortunate circumstance, inasmuch as it will enable me to place clearly before your minds some of the most important of the fundamental laws of vibration.

When our friend, the school-boy, having seated one of his youthful favorites in a swing, and by a series of judiciously timed impulses gradually increased the amplitude of her oscillations from zero to perhaps 120° of arc, proceeds, in compliance with her breathless request, to discontinue his exertions and in the classic language of the play-ground to "let the old cat die," it is hardly surprising that, not being another Galileo, our young friend has utterly failed to grasp the great physical truth that the vibrations of the little maiden are isochronous. Still less does he probably suspect that, even were he to subject the very schoolma'am herself to the same conditions, the periodicity and the isochronism of her oscillations would not differ from those of her predecessor, notwithstanding the much greater weight of the oscillating body. Nevertheless, such is the fact. It is one which was experimentally demonstrated many years ago—by myself, although of course it would hardly be becoming for me to claim absolute priority over all others in making the experiment.

Another important property of the pendulum is, that by shortening it, it oscillates more rapidly. Thus, if we take two pendulums, one of which is three and the other twelve feet in length, the shorter pendulum will be found to make two oscillations to each one of the longer one, and if we continue the experiment with pendulums of different lengths, we shall arrive at the law that the time required in each case to perform an oscillation is proportional to the square root of the length of the pendulum.

* A paper read before the annual meeting of the American Electrical Society, at Chicago, December 12, 1877.

I will also call attention at this point to a third property of the vibrating pendulum, which it will be very important for us to remember, in view of what we shall come to further on—a property which is very well illustrated by the suspended swing, to which I have just referred. It is this: A freely-suspended body, even if it be very heavy, may be set in vibration by the repeated application of a comparatively insignificant force, provided the successive applications of the force be properly timed, but not otherwise. Of course you have all noticed this in the case of the swing,

FIG. 1.

and therefore I need not enlarge upon it further than to say that the same effect is produced, though in a less degree, no matter whether the impulses are given at every vibration, at every alternate vibration, or even less frequently. The essential condition is that the intervals of time between the successive impulses shall be exactly the same as the intervals between the vibrations, or else a multiple or sub-multiple of one of these intervals.

I have made use of the suspended pendulum to illustrate some of the principal laws of vibratory motion, for the reason that its phenomena are familiar to you all, not merely because they are of every-day occurrence,

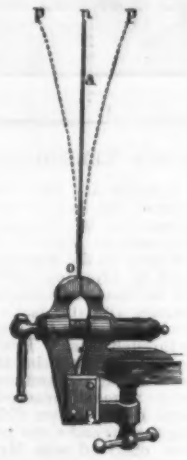


FIG. 2.

but because they are very easy of comprehension both by the eye and mind. But the laws which govern the vibrating pendulum equally govern all the varied phases in which vibratory motion presents itself throughout the realm of physics.

All solid bodies exhibit the phenomena of vibration in various forms and degrees, according to the form of the body and the manner in which the force producing the vibration is applied. Cords and wires, as familiarly seen in stringed instruments of music, have their elasticity developed by tension so as to become capable of vibration. If the cord a f b (Fig. 1) be drawn out in the middle to a c b, upon being released its elasticity causes it to return to its former position. The velocity of this movement is constantly accelerated, and is at its maximum when the cord has reached its line of equilibrium, a f b, consequently it passes with constantly decreasing velocity to a d b, where it comes to rest for an instant, and then returns to a f b, and so continues. You will at once perceive the analogy between the vibra-

FIG. 3.

FIG. 4.

tions of the central point, f, of the string between c and d and that of the weight of the pendulum, and like those of the pendulum the vibrations of the stretched string are isochronous. It may be regarded, in fact, as a kind of double pendulum, and is subject to the same laws as the ordinary pendulum. The tension and thickness being equal, the number of vibrations performed by a cord in a given time are inversely as its length. Elastic rods vibrate laterally like cords when fixed by their extremities. In consequence of their rigidity, however, they may be made to vibrate when fixed only at one extremity. Thus, a straight steel rod, n o, may be clamped in a vise, as shown in Fig. 2. If we draw the free end, n, aside and then liberate it, it will vibrate to and fro between the points p and p, as shown by the dotted lines. The amplitude of the successive vibrations, however, constantly diminishes, until at length the rod returns to its original state of rest. Such a rod, when vibrating, follows the same law as the pendulum and the stretched cord, each vibration, whether greater or smaller, being performed in the same length of time, and the number of vibrations in a given time being inversely proportional to the square of the length of the rod.

The ordinary tuning fork, an almost indispensable instrument in the experimental investigation of the various problems of acoustics, consists virtually of a double vibrating rod of the above character. As actually constructed, it is simply a steel bar, bent into the form of an elongated letter U, and supported or clamped at the middle of the bend, leaving the extremities free to vibrate. When such a fork is struck, and thrown into vibration so as to sound its deepest note, its free end oscillates, as seen in Fig. 3, where the prongs vibrate between the limits b n and f m, p and q being points of no vibration, termed *nodes*.*

Elastic plates are easily thrown into vibration, but the character of their vibrations depends upon the configuration of the plate, the manner in which it is supported or clamped, and the point at which the exciting or moving force is applied. For example, a circular plate, or a plate of any regular geometrical figure capable of being circumscribed about a circle, which is clamped or stopped at the edges, but otherwise free to vibrate, will have no decided tendency to any given rate of vibration, but will respond to any kind of vibrations which may be communicated to it. But if the plate be elongated, the normal rate of vibration is affected by the length of the plate, without reference to its breadth. The greater the length of the plate in proportion to its breadth, the more it partakes of the character of an elastic rod or a stretched string, according as it is supported at one or both ends, and thereby becomes capable of vibrating at one particular rate and no other. You will see, therefore, that we may have a succession of plates of various forms, passing by degrees from the circular plate clamped at its edges, which will take any rate of vibration with equal facility, to the string or rod clamped at one or both ends, which will only take one particular rate, rejecting all others. These properties of plates of different forms, in respect to their modes of vibration, are of the utmost importance in harmonic telegraphy, as we shall hereafter see.

It remains to speak of the vibrations of membranes, which are in many respects analogous to those of plates. When loosely stretched over a circular hoop or frame, such a membrane, like the circular plate, has no decided tendency to

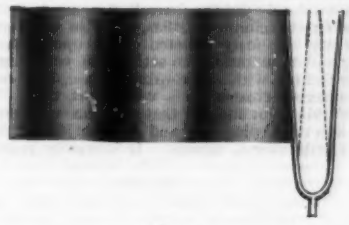


FIG. 5.

vibrate at any particular rate. If strained more tightly, however, its tendency to vibrate at some particular rate is increased.

Omitting for the present a more particular consideration of the characteristics of vibrating solids, we will now examine the effects of vibratory motion upon fluids.

If we drop a smooth, round pebble into the bosom of a placid pool, a series of concentric undulations is produced. Wave follows wave, in ever-widening circles, until opposing forces at length cause an equilibrium to be regained. At the initial point a depression is produced by the fall of the pebble. Around this there first arises a circular elevation above the surface of the liquid when in equilibrium, and immediately beyond this is a circular depression, and so on, alternately, successive elevations and depressions. When we look at this progressive series of waves, the entire mass appears to advance progressively in every direction away from the point of excitation; but if we watch the movements of some light, floating body, we shall see that this body is not carried forward over the surface, but merely rises and falls alternately as the waves pass beneath it. Moreover, we shall be able to observe an exact analogy between the vertical oscillations of this floating body and those of the suspended weight of the pendulum, or the central point of the stretched string, thus proving that the vibratory motion which we have already examined, and the undulatory motion under consideration, are manifestations of the same law under different conditions.

The undulations which we have just described are surface waves. All elastic media are also subject to undulations of a totally different character, which are termed waves of *condensation* and *rarefaction*, and are produced in air and gases by any disturbance of density. If any elastic fluid be compressed, and then suddenly released from compression, it will expand, and in its expansion exceed its former volume to a certain extent, after which it will again contract, and thus oscillate alternately on either side of its position of rest. It must be understood that this class of undulations extend equally in every direction from a center toward every point of the circumference of a sphere. This alternate condensation and expansion of an elastic fluid or medium, extending spherically around the original center of disturbance, is perfectly analogous to the series of circular waves which we have seen formed around a point of depression on the surface of a liquid, the condensation of the elastic fluid corresponding to the elevation of a surface wave, and the phase of rarefaction corresponding to the phase of depression.

Suppose Fig. 4 to represent a section of a sphere of air, or other elastic medium, in which the waves of condensation and rarefaction have extended outward from the center c, then the heavy lines, a e f g, b h i k and d l p q, will represent the phases of greatest condensation, the finer intermediate lines will represent the phases of greatest rarefaction, and the distances m n and n o, between circles of greatest condensation, will be the length of the waves.

These waves of condensation and rarefaction in an elastic medium, like the waves on the surface of a liquid, are subject to the ordinary laws of vibration, and are capable of producing, or of being produced by, the vibrations of a solid body.

The mutual convertibility of vibrations and undulations may be shown by experiment. If a tuning-fork is struck, or excited by a violin bow, and its motion allowed to gradually die away, its prongs oscillate backward and forward in the same manner and after the same law as a pendulum, except that they make many hundred vibrations for each single vibration of the pendulum. A particular tuning-fork, therefore, will always perform a given number of vibrations in a unit of time. This number depends solely upon the construction of the fork, and can, therefore, neither be in-

* Tyndall—"Lectures on Sound" (American Edition), p. 138.

creased nor diminished, unless the form or properties of the fork are in some way changed.

If we throw such a tuning-fork into vibrations, the vibrations of the fork cause undulations in the surrounding air, which are propagated in every direction. How is this brought about? Each of the prongs beats the air in opposite directions at the same time. Let us try to picture to ourselves the physical condition of the air in front of one of these prongs. As the latter strikes outward, the air in front of it will be driven outward, condensed, and, on account of the elasticity of the air, the condensation will at once start to travel outward in every direction, a wave of denser air; but directly the prong recedes, beating the air back in the contrary direction, which will, of course, rarefy the air in front of the prong. But the disturbance we call a rarefaction is propagated in air with the same velocity as a condensation. We must therefore remember that just behind the wave of condensation there is a wave of rarefaction, each traveling with the same velocity, and therefore always maintaining the same position in relation to each other. Thus the fork vibrates a certain number of times in a second, and will consequently generate an equal number of these waves, all constituted alike, and the same length. (See Fig. 5, p. 2088.) Suppose a fork to make one hundred vibrations per second: at the end of the first second the wave generated by the vibration at the beginning of the second would have traveled, say, eleven hundred feet (which is known to be approximately the distance traversed in a second by aerial vibration), and the intermediate waves would be uniformly distributed over the intervening distance; that is to say, in eleven hundred feet there would be one hundred waves, each of them evidently being eleven feet in length. If the fork made eleven hundred vibrations per second, each of these waves would be one foot long, for waves of all lengths traverse the air with precisely the same velocity.*

Now, if we place in another part of the same room another fork, so constructed as to make exactly the same number of

FIG. 6.

vibrations per second as the first one, and set the first one in vibration, the other one will soon begin to vibrate in sympathy, and it will even continue to vibrate after the first one has been stopped. Astonishing as it seems, it is nevertheless true that this heavy and rigid mass of steel has been set in motion merely by the successive impact of hundreds of tiny waves of air, each of such small motive power that it could not stir the weakest spring which was not adjusted in unison with the fork. The slightest disagreement in the respective rates of vibrations of the two forks sensibly diminishes, and a difference of one vibration in two or three hundred per second wholly destroys, the effect.

Thus we see that the isochronous vibrations of the first fork give rise to corresponding waves or undulations of condensation and rarefaction in the air, and these in turn reproduce isochronous vibrations in the second fork, and will also produce vibrations to a greater or less extent in every body which is capable of vibrating in unison with the first fork.

Thus far we have confined our attention solely to the nature and effects of simple vibrations. It remains to consider what effect is produced when a number of distinct sets of vibrations are simultaneously propagated through the same medium. Before attempting to explain this, it is desirable that we should understand the graphical method of delineating vibratory and other motions, which mathematicians and physicists are accustomed to employ in order to place the characteristics of these motions before the mind through the medium of the eye, in a manner much more intelligible than is possible even by the most minute verbal description.

Suppose we have a pendulum, swinging from right to left and from left to right, with a uniform motion. In the vicinity of either end of its path it moves slowly, and in the middle much more rapidly. If we should attach a pencil to the end of the pendulum-rod so that it would mark upon a continuous strip of paper of sufficient width, moving uniformly beneath it at right angles to the plane of its oscillation, a wavy line would be produced. This wavy line once drawn would remain as a permanent record of the kind of motion performed by the pendulum during every part of its oscillation. Fig. 6 represents a line such as would be produced by the process we have just described. It is not difficult to comprehend the meaning of the curves which are thus formed. The marking point has passed, relatively to the paper, with a uniform velocity in the direction a d. Suppose it has described the section a c in one second. Divide a c into twelve equal parts, as in the figure, then the point has been one-twelfth of a second in describing the horizontal length of any one of these divisions, and the curve shows us on which side and at what distance from the position of rest the vibrating point will be at the end of one-twelfth, two-twelfths, and so on, of a second, or generally at any given short interval of time after it has left the point a. We see, in the figure, that after one-twelfth of a second it had reached the height 1; and that it rose gradually till the end of three-twelfths of a second; then, however, it began to descend gradually, till at the end of six-twelfths of a second it had reached its main position, b, and then it continued descending on the opposite side till the end of nine-twelfths of a second, and so on. We can also easily determine where the vibratory point was to be found at the end of any fraction of this twelfth of a second. A diagram of this kind, therefore, shows at a glance at what point of its path a vibrating particle is to be found at any given instant, and thus gives a complete image of its motion.†

Although we are not yet able to make all vibrating bodies automatically record their movements on paper in this manner, yet we may ourselves construct curves which truthfully represent their vibration when the law of their motion is known; that is, when we know how far the vibrating point will be from its mean position at any given moment of time. We set off on a horizontal line, such as a b, Fig. 6, lengths corresponding to the interval of time, and let fall perpendiculars, or, in mathematical language, ordinates, to it on either side, making their lengths equal or proportional to the distance of the vibrating point from its mean position, and then by joining the extremities of these perpendiculars, we obtain a curve such as the vibrating body would actually have drawn, if it had been possible to make it do so. Physicists, therefore, having in their minds such curvilinear forms, representing the law of the motion of vibrating bodies, are accustomed to speak as a matter of convenience of the *form of vibration* of such bodies,* a term which I shall hereafter employ when referring to the subject.

We are now ready to return to the consideration of the phenomena of compound vibrations. To illustrate in a general way the characteristics of this kind of motion, we may conveniently refer again to the waves formed upon a calm surface of water. We have seen that if this surface is agitated by a pebble dropped upon it, the agitation is propagated by concentric waves extending in every direction from the center to a greater and greater distance. Now, if we drop two pebbles at two points some little distance from each other, we shall produce two separate centers of agitation. Each will set in motion a separate set of concentric waves, and these two, gradually expanding, will finally meet and overlap each other. When this happens, it is easy to see that not only the water, but any floating body upon its surface as well, will be set in motion by both kinds of agitation at the same time; but this fact will in no wise interfere with the separate propagation of both sets of waves. Each of these will continue to advance further and further over the surface, precisely as if the other had no existence. As they proceed, those parts of both rings which have just coincided appear again, distinct and unchanged in form. These little systems of waves may be accompanied by other and larger systems, caused by the action of the wind; but they will continue to spread out over the surface thus agitated, with the same systematic regularity that they did upon a perfectly calm surface.

The action of the vibrations or undulations of the atmosphere, which produce the sensation of sound, is strictly analogous to that of the waves of water. There is practically no limit to the number of distinct sets of vibrations which may be going on at the same time, without mingling with each other; but in cases where there are many of these, the resulting motion of each separate particle of air is necessarily complex, almost beyond the power of the mind to conceive. The principle, however, may be understood perfectly well by studying the composition of two or three sets of simple vibrations, and this may be readily done by the aid of the method of graphic projection, which has been before explained.

FIG. 7.

Thus, in Fig. 7, we may suppose the horizontal length of the diagram to represent a unit of time. The curve A will then represent the undulations in the atmosphere caused by the vibrations of a tuning-fork in action. The horizontal distances measured on the straight line will represent the passing time, and the vertical heights the corresponding displacements of the particles of air. Now, suppose a second fork is set in action, which is tuned an octave higher than the first, and, consequently, makes twice as many vibrations in the same time. The undulations produced by the second fork will be represented by the curve B. In such case, the curves above the horizontal line represent the compression of the air, and those below the line its rarefaction. Now, according to the laws of mechanics, if two different forces act in the same direction, the total force is represented by their sum, while if they act in opposite directions, it is represented by their difference. If, therefore, we combine these two simple curves, according to this principle, we shall have a composite curve, C, which represents the effect produced by the superposition of one set of waves upon another. The line c_1 is the sum of the lines a_1 and b_1, while c_2 is exactly equal to a_2. On the other hand, the line c_3 represents the difference between the lines a_3 and b_3, one being above the horizontal line, and the other below it. Every point in the curve C may be found in the same manner, and, by the same method of construction, the resultant curve corresponding to any number of simple curves combined together may also be found, as you will readily understand.

The simple vibrational *form* is always the same. It is only its wave height or amplitude, and its wave length or periodic time, which are susceptible of change. But the number of vibrational forms which may arise from the composition of simple forms are mathematically infinite. The converse of this proposition is also true, which is that any form of vibration, no matter how complex, may be expressed as the sum of simple vibrations. This was first mathematically demonstrated by Fourier, but its experimental proof is due to the labors of the great German physicist, Helmholtz, who, after a most elaborate series of investigations, succeeded in separating from each other the several simple sounds which form the constituents of a composite sound. It is not necessary here to enter into a description of the methods employed by Helmholtz in accomplishing this beautiful result,† although we shall have occasion to refer hereafter to some of the analogous means which have been employed in telegraphy for the same purpose, that is to say, the analysis of composite vibratory motions.

(To be continued.)

* Dolbear—"The Telephone," p. 63.

† Helmholtz—"Die Lehre von dem Tonempfindungen" (English Translation, by A. J. Ellis), p. 31.

* Ibid., p. 32.

† For a full account of the apparatus and methods employed in these experiments, see ibid., Chapter III.

JABLOCHKOFF'S METHOD OF ELECTRIC LIGHTING.

THE method of splitting up the electric current so as to supply a number of illuminating apparatus from the one source, recently published by M. Jablochkoff, comprises also a method of strengthening the currents by means of atmospheric electricity. In order to obtain useful results from a current proceeding from a source of dynamic electricity, instead of operating directly with the currents as heretofore,

FIG. 1

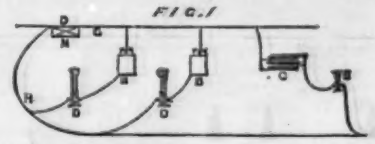


FIG. 2

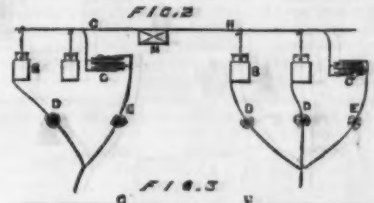
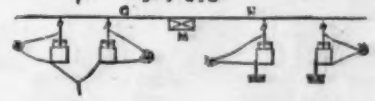


FIG. 3



M. Jablochkoff, according to his present invention, causes the same to undergo a double transformation by first converting the dynamic electricity into statical electricity, and then reconverting it into dynamic electricity, and it is by means of the latter current that he obtains useful results. For the above purpose, instead of closing the circuit of a source of electricity by means of a continuous conductor, he unites the conductor coming from one of the poles of the electrical source with one of the armatures of a condenser, composed of one or more Leyden jars of large surface, or constructed of layers of metal and insulating slabs.

The other conductor is connected in various ways, of which the principal ones are shown in the accompanying drawings. At Fig. 1, the one conductor, G, proceeding from a magneto-electric machine, M (giving alternating currents), is connected with the interior surfaces of several Leyden jars, B B, or of the condenser, C. The outer armatures of these condensers are connected to one of the charcoal points, D, of the electric candle, or with one of the ends of the slab of kaolin, E. The other charcoal point, or the other end of the kaolin slab, is connected to the second conductor, H, of the electric machine. At Fig. 2, the two conductors, G H, proceeding from a magneto-electric machine, with alternating currents, are connected to the inner surfaces of the condensers, B B, C C. The outer armatures of these conductors are connected with the apparatus for producing light, of which the second charcoal point, D, or the other end of the kaolin slab, E, is connected with earth. At Fig. 3, the two conductors proceeding from the said machine are connected with the interior armatures of the condensers. The outer armatures, at the left hand of the machine, M, are connected with earth, while at the right hand they are connected to pointed prongs which allow more readily the escape of the electricity into the air. In this case the illuminating apparatus is placed between the inner and outer armatures. The interposition of the condensers allows the current to be distributed in several directions, and it also has the object of developing atmospheric electricity and of accumulating it in the condensers, from which it is directed in the form of currents to the illuminating apparatus. The total quantity of electricity supplied to these apparatus is therefore greater than that supplied by the primitive current, and consequently produces a stronger light than that which the latter would give if led directly to the illuminating apparatus. It will be evident that this electricity can, according as may be required, be supplied either in quantity or in tension. Instead of Leyden jars it is more convenient to use as condensers those made up of plates or layers of metal, separated by insulating slabs, the metal plates, Nos. 1, 3, 5, &c., and Nos. 2, 4, 6, &c., being respectively connected with each other. Each set of plates acts as one of the armatures of the Leyden jars. For obtaining greater tension the insulating layers are constructed of a number of alternate insulating and conducting leaves or plates which are not in contact with one another. The form of the condensers may, of course, be varied, and several may be connected in quantity or in tension.—*English Mechanic.*

THE TOWER OF ASPERMONT.—The ancient tower of Aspermont in Switzerland, which crowned a mass of high rocks, and which had withstood the tempests of ages, fell lately with a tremendous crash, and crushed a number of goats which were browsing in its shadow. The castle with which it was connected was built by the Roman Emperor Valentinian in the year 368. It had long since crumbled away.

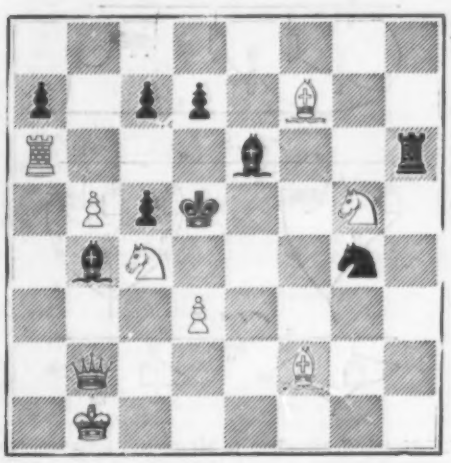
SCIENTIFIC AMERICAN CHESS RECORD.

[All contributions intended for this department may be addressed to SAMUEL LOYD, Elizabeth, N. J.]

PROBLEM No. 94. BY G. N. CHENEY.

Prize Three-mover in Leslie's Tourney of 1858.

Black.



White.

White to play and mate in three moves.

G. N. CHENEY, OF SYRACUSE, N. Y.

White to play and mate in 3 moves. ASSOCIATION LETTER TOURNEY.

PROBABLY there are but few of our readers who take any interest in chess problems who have not admired the beautiful compositions of Mr. G. N. Cheney, whose problems are found in the *Chess Nuts*, and many have wondered what has become of such a talented composer, it not being generally known that he lost his life at the battle of Bull Run.

Twenty years ago he was not only looked upon as one of our most promising and prolific composers, having originated about one hundred fine problems in a very short time, but he was one of our strongest native players, who had defeated Theodore Lichtenhein, the strongest player in the country, as well as other leading players, by a large majority. He was successful in *Leslie's* Problem Tourney, an account of which we give this week, and also won a prize in the Charleston *Courier* Tournament of 1859.

FRANK LESLIE'S PROBLEM TOURNAMENT OF 1858.

THIS interesting tournament was announced April 24, 1858, by Thomas Frere, at that time the chess editor of *Leslie's Illustrated Newspaper*. Three prizes were offered for the best single problems in three, four and five moves.

At our suggestion a novel fourth prize was added, consisting of a collection of portraits of such competitors as would contribute their pictures with an additional three move problem.

The Committee of Award, consisting of Messrs. Lichtenhein, Raphael, and Horner, after a careful examination of upward of eighty problems, awarded the prizes as follows:

Best three move. Prize to G. N. Cheney, of Syracuse, N. Y.
Best four move. Prize to J. H. Morrison.
Best five move. Prize to T. M. Brown.

The three and four move problems we give this week as our regular problems; the five-mover we find was given in SUPPLEMENT No. 125 as Enigma No. 49.

The picture prize was also awarded to T. M. Brown for the following pretty problem:

ENIGMA No. 60.—BY T. M. BROWN.

Winner of the Picture Prize in Leslie's Tourney of 1858.

White.—K on Q 2, Q K B sq, R Q B 4, B K B 2, Kts Q R 8 and K Kt 6, Ps Q Kt 5 and K Kt 4.
Black.—K Q 4, Q K B 2, B K 3, Kts Q Kt 5 and K R 6, Ps Q R 2, Q 3 and K Kt 4.
White to play and mate in three moves.

ROUSSEAU AS A CHESS PLAYER.

EVERY one is not calculated to become a Morphy or a Paulsen. Some peculiar gift, or genius, besides mere patience and love of chess, is necessary to acquire proficiency. We know that in all chess communities there is a certain class of industrious plodders, who unceasingly practice and perseveringly study everything likely to afford improvement; yet, despite their efforts, never rise above what is known as the level of the *Rook* player, but form, as it were, a ladder for more successful aspirants to ascend. A writer of eminence affirms that "the Rook player knows nothing of chess." So one who must always receive these odds can possess no genius for the game; yet many men of undoubted intelligence and mental capacity, among whom may be mentioned Napoleon, Raleigh, Fox, Voltaire, Rousseau, Franklin, and a host of other celebrities who have worshiped with devotion at the shrine of Caissa, have made such poor progress, that, like Sir Walter Scott, they were forced to acknowedge that they "could learn another language or science with less strain upon the mind." Rousseau spent many hours daily at the Café de la Régence and elsewhere in striving to acquire a knowledge of the game. He pleasantly alludes to his experience in his "Confessions." The following is a literal translation:

"There was a certain M. Baqueret, a Genevan, who, coming to Chambéry, took it into his head to teach me chess, at which he played a little. I tried almost against my inclination, and after having mastered the moves, as well as I could, my progress was so rapid that before the end of the first sitting I gave him the castle which he had given me at the beginning. There wanted nothing more; behold me mad after chess! I buy a board; I buy the 'Calabrese' (a work on chess); I shut myself up in a room; I there pass the days and nights in endeavoring to learn by heart all the games, in cramming them into my brain, right or wrong; in playing with myself without relaxation and without end. After two or three months of this fine work, and of incredible efforts, I go to the coffee-house, lean, yellow, and almost stupefied. I try myself with M. Maguret; he beats me once, twice, twenty times; so many combinations were jumbled together in my brain, and my imagination was so deadened, that I saw nothing but a fog before me. As often as I have exercised myself with the book of Philidor or Stamma, in studying games, the same thing has happened to me; and after having worn myself out with fatigue I find myself more feeble than before. Now, whether I have abandoned chess, or by playing got again into practice, I have never advanced a notch since that first sitting, and I have always found myself at the same point where I was after finishing it. Were I to practice thousands of ages, I should end with being able to give the castle to Baqueret, and no more. There is time well spent, you will say, and I have not spent a little at it. I only ended this first essay when I had no longer strength to continue it. When I made my appearance at first issuing from my chamber, I looked as one risen from the grave; and had I continued the same course, I should not have remained long above ground."

G. N. CHENEY, OF SYRACUSE, N. Y.

THE GREAT CORRESPONDENCE MATCH—AMERICA VS. ENGLAND.

THROUGH the courtesy of Mr. Belden, we are enabled to give our readers the latest game from the International Correspondence Match, which scores one more for America, the total now being—America, six; England, four.

(*Evans Gambit.*)

ATKINSON.		WAIGHT.
WHITE.		BLACK.
1. P to K 4		1. P to K 4
2. Kt to K B 3		2. Kt to Q B 3
3. B to B 4		3. B to B 4
4. P to Q Kt 4		4. B x P
5. P to B 3		5. B to R 4
6. Castles.		6. Kt to K B 3

A very risky line of defense to adopt in a correspondence game; P to Q 3 would have been preferable.

7. P to Q 4	7. Castles.
8. P x P	

We see no harm in the capture of this pawn, although a better move would have been Q to B 2.

	8. Kt x P
9. Q to Q 3	9. Kt to B 4
10. Q to Q 5	10. Kt to K 3
11. B to R 3	11. R to K sq
12. P to Kt 3	

A better move than it looks, not so much for the purpose of guarding B 4, as preparing to play Kt to R 4 and advance bishop's pawn, which line of attack black does well to prevent. A wag at our elbow suggests that if white had played P to K R 3 the game would in all probability proceed as given in the text, and white would have had a beautiful three move mate on his 21st move.

	12. B to Kt 3
13. Q Kt to Q 2	13. Kt to K 2
14. Q to Q 3	14. Kt to Kt 3
15. Kt to K 4	15. P to K B 3

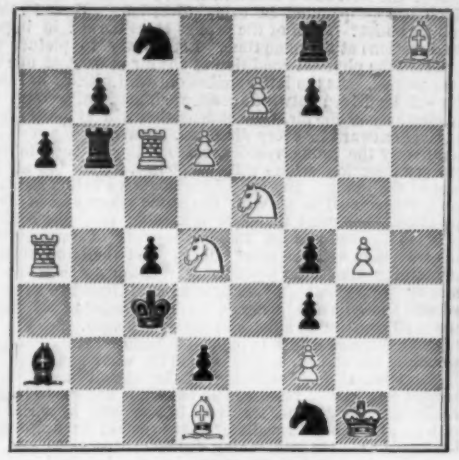
This move seems equivalent to giving the game into white's hands; the impetuosity of our youth would have induced us to attempt to turn the attack by playing P to Q 3, which might have proceeded as follows:

	15. P to Q 3
16. P x P	16. Kt to K B 5
17. P x Kt	17. Kt x P
18. Q to B 2	18. B to B 4, and white has a most difficult game to defend.
16. P x P	16. P x P
17. Q to Q 5	17. P to Q B 3
18. Q to K B 5	

PROBLEM No. 95. BY J. H. MORRISON.

Prize Four-mover in Leslie's Tourney of 1858.

Black.



White.

White to play and mate in four moves.

Apparently the only move to prevent the advance of queen's pawn.

	18. K to Kt 2
19. Kt to Q 6	19. R to R sq
20. Q to R 5	20. R to K Kt sq
21. B to B sq	21. R to R sq

The last three moves of black are an inexcusable waste of time.

22. B to R 6 ch	22. K to Kt sq
23. Kt to R 4	23. Kt to K 4

And white announced mate in eight moves.

SOLUTIONS TO PROBLEMS.

No. 90.—BY RUDOLPH WILMERS.

WHITE.	BLACK.
1. Q to Kt 3	1. K to Kt 4
2. Q to Q Kt 3	2. K to R 4
3. Kt to Q B 3	3. Any move
4. Mates.	
	1. K to Q 4
2. Q to K 5 ch	2. K to B 5
3. R to R 3	3. Any move
4. Mates.	
	1. K x P
2. R to Q sq ch	2. K x Kt
3. Q to B 3 ch	3. K moves
4. Q to K 3 mate.	
	1. B to K 2
2. Kt to Q 6 ch	2. B x Kt
3. Q to Q 3 ch	3. K moves
4. P mates.	
	1. P to Kt 6
2. Q to B 3 ch	2. K to Q 4
3. Q to B 5 ch	3. K x Kt
4. Q mates.	
	1. R x Kt
2. Kt to Q 6 ch	2. K x P
3. R to Q sq ch	3. K to B 4
4. Q to B 2 mate.	

No. 91.—BY SAMUEL LOYD.

WHITE.	BLACK.
1. K to Kt 4 (x Kt)	1. P x R
2. Kt to B 2 ch	2. P x Kt
3. Q x P ch	3. K x Q
4. P to K 4	4. K to K 3 or 5
5. B mates.	
	1. R x Q
2. P x P ch	2. K x P
3. K R to K B 2	3. B to Kt 6
4. Q R to K 2	4. Any move
5. Mates.	
	1. B x R
2. P x P ch	2. P x P
3. R to K B 2	3. P x R
4. B to Kt 4	4. Any move
5. Mates.	
	1. P queens
2. P x P ch	2. K x P
3. Kt to B 4 ch	3. P x Kt
4. B to K 2 ch	4. K to K 4
5. R mates.	
	1. Kt to B 4
2. P queens	2. Kt to K 3
3. Q x B	3. B x second Q
4. Kt x P ch	4. Kt x Kt
5. R mates.	

ENIGMA No. 57.—BY CONRAD BAYER.

WHITE.	BLACK.
1. P to B 5	1. B x P
2. Kt to R 3	2. P x Kt
3. R to K 4	3. Any move
4. Q mates.	

LETTER "J."—ASSOCIATION TOURNEY.

WHITE.	BLACK.
1. Q to K Kt 3 ch	1. K to Q 5
2. Q to Q 3 ch	2. K moves
3. Q to Q 5 mate.	